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PAPER SHORTAGE, EDUCATION AND RESEARCH

THE debate on the book publishing trade in Great Britain which took place in the House of Commons on the adjournment on May 9 reflected general disquiet on the subject. The position had previously been the subject of letters to the Press by Sir Stanley Unwin and others, and of questions in the House of Commons itself, replies to which from the Government had not given satisfaction. The shortage of paper supplies existed before the fuel crisis, and the unsatisfactory position in regard to scientific and technical books was discussed in *Nature* of December 28. Sir Stanley Unwin in a letter to *The Times* stressed the way in which even Government departments as well as the schools and colleges have now become handicapped by the scarcity of books, and referred to the inability of publishers to meet the insistent demand abroad for British books, which can be looked upon as valuable contributions to the country's export target and also as a means for promoting knowledge of the British way of life.

These three points were brought together in the motion cited by Mr. Wyatt, which urged the Government to accept the principle that book publishing is an essential industry deserving a greater and more appropriate measure of priority in view of its importance to the culture of the country and to the export trade, and the necessity of maintaining and increasing the provision of text-books for schools and universities. Mr. Wyatt urged that the small amount of coal and paper consumed in book publishing is out of all proportion to the immense value to the community of books produced. Not more than about 2·5 per cent of the paper used in Britain goes to book publishers ; Mr. Wyatt pointed out that 71,000 tons a year was consumed by the Stationery Office as against only 54,000 tons in 1946 by all the book publishers together. It is at present quite impossible to replace ordinary standard works to make good the ordinary wear and tear of libraries, quite apart from the replacement of copies destroyed during the War. All reserve stocks of paper for books, particularly school-books, have been used up, and with their present paper quota publishers cannot possibly begin to make up the present deficiency of books for schools or colleges, or of recognized classics, and at the same time continue publishing as a live industry.

The demand is, of course, greatly accentuated by the raising of the school-leaving age, the expansion of the universities and the increased demand of the public for reading matter which has grown up during the War. While every university or public library can bear witness to the intense and largely unsatisfied demand for text-books of all classes, including the set books for examinations, and to the number of students whose needs are not met, Mr. Wyatt pointed out that another serious feature of the situation is that the culture of the country is being stifled because publishers cannot publish the works of new authors. Mr. Wyatt, after referring also to the export trade

and to the prestige value of British books abroad as more important than the financial aspect, emphasized particularly the way in which the sale of technical books abroad is being captured by the United States. The output of British scientific and technical books during recent years has been low enough, but Mr. Wyatt pointed out that because we cannot export our books, American publishers are buying the copyright to export them themselves, and their export trade in books has already risen from about £1,500,000 a year to three times that figure. Not only are books completely overlooked in the matter of priorities, but also the paper salvage drive is being neglected.

The debate itself illustrated the lack of appreciation of the position on the part of the Government, for the time allowed no other speeches than those of Mr. Wyatt and Mr. Belcher, Parliamentary Secretary to the Board of Trade, in reply. Mr. Belcher, who maintained that the Government does consider books an important part of the life of the country, urged that the position is not entirely due to lack of fuel: there is a twenty per cent deficit of labour in the printing and bookbinding trades, and machinery has suffered from seven years depreciation and lack of replacement, apart from the destruction of about 5,000 printing machines during the War. Replacements will take from one and a half to two and a half years; the greatest problem, he said, is bookbinding machinery, which the Government is now arranging to import from the United States. Last winter, publishers were allocated 80 per cent of their pre-war consumption of paper, with an additional 10 per cent for export; and when, following the fuel crisis, it was agreed with the Publishers' Association to reduce the 80 to 70 per cent, the Government undertook to license in a subsequent period supplies to make up any deficiency on the 70 per cent in any one period. The coal allocation was increased from 33⅓ in March to 50 per cent in mid-April, and from June onwards the mills will receive an allocation of fuel equal to their full consumption in the summer of 1946. Paper supplies should therefore, according to Mr. Belcher, shortly reach the level anticipated before the fuel crisis, and the Government has made arrangements under which book publishers will receive a basic allocation of 60 per cent of pre-war consumption. In addition, they will be allowed 20 per cent, provided they devote the same proportion as before of their 60 per cent quota to educational or export books, and give an undertaking that they will use the additional 20 per cent for increased production of educational books for use in schools, colleges and universities and for home study, or for increasing their export targets. If, in the future, the amount of paper for book publishing were increased, the Government would hope to maintain these arrangements, with proportionate increases in the 60 per cent and 20 per cent figures. Mr. Belcher added that arrangements already made for publishers to receive from the special reserve of paper extra allocations for the production of essential books which they are unable to produce from their own quota would continue, and the Government has decided to divert from the reserve 1,000 tons for the production of educational text-books.

Much turns on the use of the term 'allocation'; in this connexion it means 'permission to buy' and is in no sense a guarantee that supplies will be obtainable. Further, the reference to the special reserve of paper, better known as the 'Moberley pool', is obscure; this reserve, of 1,500 tons, was established for the production of cultural and educational books, subject to detailed inquiries, and it is not apparent what change in policy is intended.

Moreover, there were several points raised by Mr. Wyatt and Sir Stanley Unwin to which no reply was made. The point about exporting paper, and particularly coated papers, was ignored; and Mr. Belcher in his reference to machinery did not indicate that the industry is to receive any priority in the replacement of worn-out machinery or in the allocation of raw materials. It is, in fact, the ignoring of this claim to priority and the absence of imagination in Mr. Belcher's reply which are the most disturbing features of a situation in which the virtual embargo on the output of new literature and of scientific and technical books is likely to persist.

Mr. Belcher may have dismissed the idea of salvage too lightly, and more might be done in the way of paper economy in the myriad fields in which paper is used in a modern community. It is, however, the manifold nature of those uses and the complex way in which they are entangled with almost every aspect of the life of the citizen—business, industrial and civic, as well as educational and cultural—that makes it so important that supplies should be brought to an adequate level as a priority of the first importance to every section of the community and every aspect of national life.

Here we cannot allow to pass unchallenged the question of the production of scientific and technical books. Apart from the fact that, as Mr. Wyatt pointed out, the sale of British technical books abroad tends to stimulate the sale of the British machinery and equipment described in such books, and from the prestige element attached to sales abroad of such books, it is not altogether desirable that scientific men and technologists in Great Britain should be so largely dependent on books from other countries in their work. Scientific and technical advance in Britain might well be assisted if an attempt could be made to restore the balance which seven years of preoccupation with the demands of war has upset. British achievements and advances should be made known to the world at least in part by the men responsible, and also in books produced in Great Britain.

There is a further factor which was most evident at the time of the fuel crisis in the suspension of scientific and technical periodicals, but which, as was pointed out at the time, is an inevitable consequence of the shortage of newsprint. Scientific work and interests, as well as knowledge of public affairs, are liable to suffer from the compression and selection that are involved when newspapers and periodicals are severely limited in size. Scientific and technical factors themselves are often involved in the formation of sound public judgments on such matters as the fuel crisis, even though the problem appears at

first sight to be purely political. Lord Marley, for example, pointed out in the House of Lords how neglect to apply available knowledge resulting from scientific research into fuel problems had contributed to the fuel shortage. His criticism was directed against sections of industry as well as against the Government itself; but if sound policy is to be evolved and appropriate administrative action taken, it is important that scientific and technical opinion should have the opportunity to express itself effectively before policy has been determined. The point is the more important because there are indications that measures of rationing contemplated are of the type that penalizes the efficient consumer, whether individual or industrial, and those who have responded most loyally to the appeal for economy.

The suspension of the scientific and technical Press of the country was a serious hindrance to the expression of informed, responsible and constructive criticism on certain highly important aspects of the situation, and in that alone was a threat to what is usually understood by 'the freedom of the Press'. Nor is that all. While in the technical field to which we have just referred, the ability of the engineer, the chemist, the physicist, the fuel technologist, and others to express sound judgments is unquestioned, there are also fields, such as that of management and administration, where the scientific worker and technologist have not only the duty to express an opinion when they can do so from personal knowledge and experience, but also where they may often be at least as competent to utter sound judgments as their fellow citizens. Only the most outrageous casuistry can pretend that behind the immediate physical difficulties, which precipitated the fuel crisis and the long series of handicaps which the Government inherited from the past, there has not been the human contributory factor of procrastination and inept administration.

Scientific workers or technologists cannot be expected to make their due contribution to social and public affairs if arbitrary action such as occurred in the fuel crisis is allowed to obstruct informed comment and responsible criticism. It cannot be denied that the situation which involved the suspension of periodicals was preventable, and with reasonable foresight and competent administration would not have arisen. As the Commission on Freedom of the Press in America points out in a general report entitled "A Free and Responsible Press", if freedom of the Press is to achieve reality, Government must set limits upon its capacity to interfere with, regulate, control, or suppress the voices of the Press, or to manipulate the data on which public judgment is formed; and it goes on to point out that without intruding on press activities the Government can even help to improve the conditions under which such activities occur, and remove hindrances to the free flow of ideas instead of thwarting that flow, and promote, instead of check, the reality of public debate. Freedom of the Press is indeed no less essential to scientific advance than to political liberty and to the creative activities on which the spiritual life of men depends. Where, as the Commission observes, men cannot freely convey their thoughts to one another, no freedom is secure. Moreover, science itself is a part of that civilized society which is a working system of ideas; and like it, lives and changes by the consumption of ideas, and can only indeed serve the society of which it forms a part by ensuring that as many as possible of the ideas of its members are available for examination by the scientific method, and that the results of scrutiny are fully and freely made known to society. That is the fundamental reason why the scientific worker as such is bound to protest against restrictive administrative action; this applies whether the action is due to lack of imagination as in the question of paper supply for books, or to the failure to observe in the fuel crisis the restraints which, as the American Commission insists, a democratic government is morally bound to respect in all circumstances.

PHILOSOPHY AND ITS BACKGROUND

History of Western Philosophy and its Connection with Political and Social Circumstances from the Earliest Times to the Present Day

By Bertrand Russell. Pp. 916. (London: George Allen and Unwin, Ltd., 1946.) 21*s*. net.

IF one grants the assumption as to the nature of philosophy on which this book is based, it is a remarkable achievement. The assumption is, as Lord Russell says in the introduction, that philosophy is something intermediate between theology and science; it is a no-man's-land; it is speculation about the nature of the universe and the nature of things, based on the assumption that you can get definite answers on such subjects by speculation. Lord Russell does not think that you can do this, but the belief in the powers of such speculation has persisted and has produced many interesting results.

Western philosophy so conceived begins, not with Socrates but with Thales, and what this book does is to review the long history of men's speculations from Thales to the present day. The views of the philosophers are described with the beautiful lucidity of which Lord Russell is a master, and as he describes the views of one philosopher after another he adds witty, waspish, cynical and wise comments. If Edward Gibbon had been a philosopher instead of a historian, he might have produced a book very like this. It is a curious history because, according to Lord Russell, it has been all wrong. We have now, at long last, discovered that this speculation is vain. The answer to that effect has been finally and conclusively given by logical positivism. Yet I think that Lord Russell would still have us study philosophy, because he discerns as a by-product of this curious, mistaken activity a certain emotional temper, a certain contemplative attitude towards the world which he thinks is of great value.

Lord Russell makes a point of accompanying the accounts of the speculations of the philosophers with a statement of the historical background from which these speculations came. It appears to me that the idea is sound and valuable, but I cannot think much of the execution. I do not think that Lord Russell is a historian. The history is accompanied by interesting and illuminating comments,

but some of it seems to me just the expression of Lord Russell's dislike, and not history at all. One has only to compare, for example, the chapter on "Die Anfänge des Judaismus" in Edward Meyer's "Geschichte des Altertums" with Lord Russell's chapter on the Jews to see what poor stuff the latter is. What is more curious is that Lord Russell does not really connect the history with the philosophy. His account of the philosophers is curiously unhistorical. He examines the work of one of them after another, selects the propositions which they believe to be true and which interest him, compares them with his own views, all as though they were contemporaries and not in the least as though their philosophy was integrated with, or really part and parcel of, the historical time in which they were living. It surprises me very much that anyone can discuss Socrates without describing the crisis through which Athens was passing in the fifth century as told, for example, by Thucydides. He writes of these various Greek philosophers of that time as though they were interesting and brilliant people who happened to turn up then, but who were not, as people, really concerned about the state of their civilization. All that Lord Russell does with the historical side is to show that this aloof, contemplative, speculative faculty as it appears in one man after another is to some extent influenced by historical events. I do not think he does anything like justice to the real interpenetration of philosophy and history. But that again is the result of his conception of what philosophy is.

One result of this conception of philosophy is that it confines philosophy to logic and metaphysics. There is nothing about the philosophy of history, and therefore not a word, in the modern section, about Vico or Croce or Dilthey. Similarly, there is nothing about æsthetics, and, most significant omission, philosophy does not include moral philosophy. Of course, Lord Russell has to make remarks about the moral views on philosophy held by Socrates, for example, or Locke; but he does not pay very much attention to them; they are not his concern. It is to me, therefore, no accident that Lord Russell seems to take a very unfavourable view of Socrates and Plato and, more especially, of Emanuel Kant, for their conception of philosophy was entirely different from his.

Perhaps the easiest way to put the point I want to make is to ask why earlier historians of philosophy have always held that Greek philosophy began with Socrates. They all, of course, recognized that the so-called pre-Socratics had something to do with philosophy; they held, nevertheless, that philosophy proper began with Socrates. The explanation is that Socrates was not just concerned with what Lord Russell regards as philosophical questions; he was concerned with the problem of standards in general. Socrates thought that Athens was going to pieces because the democracy of the day repudiated moral and political standards. He was sure that there were such standards, and he made it his business to examine and vindicate them. He did so very largely by directing attention to the existence of scientific standards in mathematics and by asking himself what was the relation between moral standards, or 'the just', and mathematical standards. Plato's theory of forms, which was an elaboration of Socrates, was not just a theory of universals; it was a theory of standards. Plato, for example, did not think there was a form of green; for we do not conceive of there being a green which is greener than any visible green. Socrates began by comparing the political teachers of the time unfavourably with craftsmen. The craftsmen at least knew the difference between good and bad work. The mathematicians knew the difference between mathematical thinking and vague guessing and purely empirical measuring. The recognition of the fact that there are good and just men as there are bad and unjust men is, to Socrates and Plato, and, for that matter, to Aristotle, a fundamental fact that has just got to be reckoned with. What philosophy does, as Plato explains in the Republic, is to reflect on the assumptions and hypotheses of the different inquiries and to consider their relation to one another. Such reflexion is clearly not in vain; it is very concrete and very definite. Of course, such reflexion on the nature of standards may, and in Plato does, result in conclusions which Lord Russell would call speculative. There is a very great division which runs through philosophy, conceived in the Platonic or Kantian sense, between those who hold that reflexion on assumptions and hypotheses leads to an apprehension of supersensible realities, and those who do not. Dialectic for Plato leads to such apprehensions; for Aristotle it is a form of false reasoning; for Hegel it is the highest form of knowledge; for Kant it is illusion. But that does not alter the fact that all these philosophers begin with the solid facts of human achievement, with the facts of right thinking and good conduct and fine art and just government.

This contrast I have been trying to make comes out more strikingly than ever if you compare Lord Russell's treatment of Leibniz with his treatment of Kant. Leibniz is, perhaps, his favourite philosopher and he puts him very high. Leibniz had an extraordinarily ingenious speculative mind, and, in my judgment, no sense of reality whatever. But he could perform to perfection the kind of ungrounded speculative thinking with which Lord Russell identifies philosophy. When Lord Russell comes to Kant he explains that he does not think much of him: of that one cannot complain; but the extraordinary thing is that he considers Kant's most important contribution to be his view of space, a view taken by Kant in his pre-critical period; and what Kant regards as his far-reaching discovery, that metaphysics should be criticism, is not expounded or examined. Kant is not a speculative philosopher; he does not believe in speculative philosophy. He started with his feet most firmly on the ground, with being quite certain that there was all the difference in the world between science properly so-called and what he describes as "groping around"; between doing what you ought and doing what you happen to like; between great art and finding what would tickle the public; and he sets himself to ask how these great achievements of the human spirit were possible, how alike or how different they were in methods and assumptions and what they implied.

Those seem to me to be the two main ways of regarding philosophy. I entirely accept the Kantian revolution, and therefore I cannot be expected to have much sympathy with Lord Russell's pre-revolutionary conception. But, as I said at the beginning of this review, if you do accept Lord Russell's assumption as to what philosophy is, this is a very remarkable performance. For those who like this sort of thing, this is indeed the sort of thing they like.

LINDSAY OF BIRKER

CAUSAL FACTORS IN SCHIZOPHRENIA

The Biology of Schizophrenia

By Dr. R. G. Hoskins. Pp. 192. (New York: W. W. Norton and Co., Inc.; London: Chapman and Hall, Ltd., 1946.) 15*s*. net.

THE greatest problem of modern psychiatry is that of schizophrenia. The vast majority of the permanent occupants of the mental hospital consists of patients suffering from this disease, which besides cripples a large number of patients who contrive to live a precarious existence in the outside world as tramps, eccentrics, prostitutes and similar misfits.

Dr. Hoskins' book is a valuable review of this psychosis. It is an expanded version of his three Salmon Lectures. The first part is devoted to a description of the development of human personality and social community on the basis of emergent evolution. The second part is a description of schizophrenia as a pattern and the comparison of it with various biological reactions found in other animals. It is the third part which will be of most interest to the clinical psychiatrist and the research worker. In this part he reviews a large amount of modern literature and examines the various possible causes for the curious symptoms which characterize this disease. He examines the endocrine factors, the oxygen relationships, the carbohydrate metabolism, the circulatory conditions and the importance of haemostasis. Many of the facts which Dr. Hoskins discusses here have been determined by his own research team at Worcester State Hospital.

It is obvious that in research upon an obscure disease process such as schizophrenia there is no one method of approach; but it is rather the correlation of the multitudinous minor discoveries which will give the final clue. Dr. Hoskins wisely takes the biological stand and attempts to fit together what is known; but unfortunately not enough has yet been discovered to make it possible to solve the problem. He seems to think that the avenues of research tend to lead towards the problem of maturation as related to the endocrines, vitamins and enzymes. He points out that the schizophrenic is lacking in empathy (the basis of emotional relations with others), and that if we could discover the cause of this deficiency we should be advancing our chances of solving the whole problem. In this matter he points out that feral children—children who have been adopted by wild animals since an early age—are totally lacking in power to show empathy. He suggests the importance of inheritance by quoting the well-known work on twins, in which it was shown that if one of monozygotic twins developed schizophrenia this also tended to appear in the other, while dizygotic twins did not show similar reactions.

Dr. Hoskins shows an easy tolerance to all schools of psychiatry and writes fairly and generously from all points of view. His style is clear and understandable—a virtue not always found in psychological books. The format itself is excellent, the print is clear, with wide margins such as have not been seen in Britain since the paper shortage. The binding is good. There is a long list of references, which are valuable to those who wish to read one particular part of the literature, and there is an excellent index.

CLIFFORD ALLEN

A BIRD PHOTOGRAPHER ABROAD

Bird Life in Two Deltas

Being the Diaries of a Bird Photographer in the Estuaries of the Guadalquiver and the Rhone and their Neighbourhoods. By G. K. Yeates. Pp. 159+68 plates. (London: Faber and Faber, Ltd., 1946.) 15*s*. net.

THE standard of bird photography has risen high in recent years, but we have no better exponent of the art, for an art it has become, than G. K. Yeates. His bird portraits are superb examples of the work of the camera. In his latest book, "Bird Life in Two Deltas", we see pictures taken in Spain and in the south of France. "The Spanish *marismas* at the estuary of the great Guadalquiver and the Camargue or Rhône-Delta constitute two of the greatest bird paradises in Western Europe", says the author. He goes on, "The brief visits of a foreigner to these great oases of bird-life, so vast that even a lifetime would leave much unseen and unexplored, can in themselves provide only a fleeting glimpse into the wealth and variety of their natural history. These three diaries which follow are the unadorned records of my visits."

But the diaries, if 'unadorned', are not the less interesting for that, for they tell a plain story very well, the story of a naturalist in a rich field, of his difficulties, his triumphs and his many observations. Here is his account of flamingoes: "Never have I been so moved by the sheer wondrous beauty of a bird as I was today by these flamingoes. . . . We first saw the birds as a long thin pink line through the mirage. As we came closer, they assumed more definite shape. When wading through the shallows, the flamingoes' general colour scheme is a very soft pink. The body appears like a round ball precariously balanced on two long pink stilts. The long thin serpentine neck with the curious heavy downward-tilted bill completes a strange picture. . . . The soft reflections of the long thin pale-pink line in water that took its colour from the blue of the sky defeat my poor pen for description."

Yeates adds: "Lovely as is the flamingo as it wades, it is a flash of glory on the wing, for then instead of the soft pinks which predominate on the ground the bird exposes the brilliant scarlet of the covert feathers . . . nor is it just one bird in the air. Numbers on such a scale are difficult to estimate, but I do not think 1,500 far short of the birds that were here present."

Buff-backed herons, little egrets, black-winged stilts, night herons, hoopoes, etc., provide the author with many observations on bird behaviour and with photographs of remarkable quality.

Of special interest are his records of the penduline tit in the act of constructing its nest. Photographs of nest-building are rare. This species contrives a lovely little domed nest after the style of that of the familiar long-tailed tit, but uses reed 'down' instead of moss and lichen. A favourite site is among the drooping sprays of tamarisk. We here see stages in the building, an outer circle or hoop being first constructed, in which the bird works and builds up the main walls.

Several useful appendixes are to be found at the end of the book—a bibliography which will be helpful to anyone desiring to look up the literature of these bird paradises, a list of scientific names and a list of the French names of the Camargue birds.

FRANCES PITT

BRITISH SCIENTIFIC INSTRUMENTS

PHYSICAL SOCIETY'S EXHIBITION

THE healthy condition of the British scientific instrument industry was again demonstrated at the second post-war exhibition held by the Physical Society at the Imperial College of Science and Technology, South Kensington, at Easter. In the past it has been customary to hold the exhibition early in January, but owing to the extraordinary and unforeseen large increase in attendance at the first post-war exhibition (held January 1946), it became necessary to make fresh arrangements. These took the form of a restriction in the number of tickets issued (limited to about 12,000), an increase of the floor space of the exhibition (extending into a part of the Science Museum), and an increase in the period during which the Exhibition was open, from three to four days (April 9–12 inclusive). It was mainly due to this latter change that the Exhibition, the thirty-first of the series, was held at Easter instead of the New Year. These changes certainly had the desired effect, and visitors this year were able to view the splendid display of scientific instruments under relatively comfortable conditions.

Owing to paper supply and printing difficulties arising from the fuel crisis, it was not possible to produce the catalogue in time for the Exhibition. Consequently, a concise 8-page guide was issued for the convenience of visitors to the Exhibition, followed afterwards by the catalogue itself, a well-illustrated volume of about 380 pages. This catalogue is much more than a guide to the Exhibition: it is, in fact, a work of reference containing descriptions of a very large number of scientific instruments manufactured in Great Britain during recent years.

The Exhibition was a tribute to the high degree of skill and ingenuity shown in the design and manufacture of high-class scientific instruments in Britain. As in previous years, it was divided into two main sections, namely, the Trade Section and the Research and Educational Section. The Trade Section included exhibits from 118 firms of instrument makers, while the Research and Educational Section was represented by twenty-nine organisations, many of these being Government research establishments. During the Exhibition, four discourses were given on recent advances in various aspects of the development of scientific instruments. One of these, given by Dr. Edward Lee (of Admiralty Research Laboratory, Teddington), dealt with the development of certain types of Service infra-red equipment which has in post-war years found valuable applications in research and industry. He dealt in particular with the image-converter tube in which infra-red radiation up to a wave-length of 1·3 μ is transformed into visible radiation. During the discourse the audience were supplied with the Service type of this tube (the R.G. tube) enabling them to see demonstrations of various interesting infra-red phenomena. Dr. Lee referred also to recent progress in the production of lead sulphide photo-conducting cells sensitive up to a wave-length of 3·5 μ. These cells have been used recently in observing transient low-temperature effects which were previously undetectable. He referred to the use of infra-red equipment fitted to military vehicles for driving at night and to the detection of the exhausts of enemy aircraft.

Interesting and instructive discourses were also given on "Recent Advances to Optical Science" and on "Air Photography" by Mr. B. K. Johnson (Imperial College) and by Mr. A. C. Brock (Royal Aircraft Establishment, South Farnborough) respectively. Prof. A. Porter in his discourse dealt with the important subject of "Automatic and Manual Position Control Systems". His remarks were based on various mechanical aspects of fire control and radar systems as used in the Services. He was mainly concerned with a discussion of the relative effects of inertia and damping in follow-up mechanisms, and the introduction of controls including the first and second differentials of displacement.

These discourses are not only of interest to the specialists but have also a more general appeal, and are now one of the important features of the Exhibition. Another feature which is gradually assuming greater importance is the exhibition of scientific and educational films. One of these, of more popular interest, was a 50-min. film depicting episodes in the life of Lord Kelvin. The British Kinematograph Society showed ten films illustrating the uses of motion pictures in scientific research; for example: (1) kine radiograph of normal human joints; (2) super-slow motion of a splash; (3) films in aircraft research, etc. Another film, shown by Kodak, Ltd., Research Laboratories, illustrated the use of the phase-contrast microscope in biological studies.

In a brief review of the Exhibition, it is almost impossible to select even a representative sample of the very numerous exhibits for reference. The following, taken almost at random, may, however, serve as a rough indication of the type of exhibits to be seen. Microscopes, for example, in recent years seem to be departing more widely from the old conventional forms. In the Research Section was shown a reflecting microscope having a numerical aperture of 0·98, with exact focal achromatism, fitted with phase-contrast illumination. Using this instrument, photomicrographs of stained and unstained material (by phase contrast) were shown. Another microscope, of an entirely different type, is the electron microscope. This has now been used in a 'shadow casting' method. Shadow-casts are formed by irradiating a supported specimen obliquely, *in vacuo*, with a stream of gold molecules. Such objects when viewed by transmission in an electron microscope show shadows and gradations of density in a pattern which indicates the detailed shape of the original specimen. A 50 kV. electron microscope, giving total magnifications of the order of 20,000 times, was on view in the Trade Section of the Exhibition. The resolving power of the instrument was stated to be better than 100 A.

Reference has been made to infra-red sensitive cells in Dr. Lee's discourse. The characteristics of lead-sulphide cells as applied to high-speed low-temperature pyrometry were shown in the Research Section. One exhibit demonstrated the quick response-time of the lead sulphide cell, about 20 microsec. at room temperature. At the peak of its sensitivity curve (2·7 μ), it is almost a hundred times as sensitive as the best thermocouple. At liquid-air temperatures its sensitivity is greatly increased, but its response time is now of the order 500 microsec. In addition to its use in spectroscopy, the lead sulphide cell is finding many applications in industrial processes and in research.

Developments in electrical (and electronic) instruments are particularly noteworthy, and more 'Service' applications were released in time for this Exhibition. One form of bomb locator which was exhibited was

in principle a very sensitive magnetometer for measuring the distortion of the earth's magnetic field due to the presence of ferro-magnetic material. The sensitive element in this locator is a length of mu-metal wire, the A.C. resistance of which varies with the field along the axis of the wire. Variation of the resistance is indicated by a sensitive bridge circuit. Two widely spaced elements are used to indicate the field gradient.

Perhaps one of the most popular and striking exhibits was the demonstration of centimetre waves and the equipment used in the generation, transmission and reception of centimetre waves. Wave guides, magnetrons, klystrons, dielectric rod and tube aerials, lens-corrected horns, crystal receivers, concentric probes, bolometers for power measurement, polarization-plane changers, etc., for use in micro-wave communications and research were to be seen on several stands both in the Trade and Research Sections. Demonstrations were given illustrating the properties of centimetre waves such as reflexion, focusing, stationary waves, polarization and attenuation.

In the Trade Section a cathode ray tube known as the 'Skiatron' was demonstrated. In this tube the electrons, instead of causing fluorescence when they strike the screen, produce an image of varying opacity which can be projected on a screen, using conventional sources of high-intensity illumination, instead of relying on the relatively weak illumination produced on a fluorescent screen.

Another interesting exhibit in the Trade Section was the equipment used in picture telegraphy. This equipment was designed primarily for use by the Press for the transmission of news-pictures directly over existing telephone networks, or in conjunction with radio links. The commercial applications are obvious, and the system offers possibilities in crime detection, since it permits of rapid transmission of finger-prints and other pictorial matter. The definition obtained in this system is very good, and the speed of scanning satisfactory; for example, a picture 10 in. × 8 in. can be transmitted in 7–20 min., according to the scanning-line and drum speed combination.

An entirely novel feature in this year's Exhibition was the exhibit of the Atomic Energy Research Establishment (Electronics Group). Electronic β-ray counters and health monitors for β- and γ- and slow neutron radiations were demonstrated. Much interest is being taken in the design of Geiger counters and in various forms of apparatus for measuring ionization, with associated electronic equipment. Counting rates as high as 5,000 a minute are now readily obtainable—this compares very favourably with the normal rates of 20–30 a minute when counting α-particle scintillations by eye. The importance of the exhibit was not so much in what it actually showed as in what it foreshadowed.

In acoustics, improved types of noise meters were exhibited, and a demonstration was given of the absolute pressure calibration of a microphone by measurement of the amplitude of smoke particles. A novel application of soap films was demonstrated in gas analysis apparatus embodying a dynamic method instead of the more usual static method. The apparatus consists of eight soap film meters incorporating the necessary absorbent solutions. To carry out an analysis, which can be completed in three minutes, soap films are formed in each meter by raising and lowering valves.

The use of silicone-insulated windings in electric motors running at abnormally high temperatures was demonstrated in another research exhibit.

It is hoped that the above examples sufficiently illustrate the wide range covered by the exhibits. It is practically impossible for the normal visitor, who has only one day to spare to visit the Exhibition, to see everything. All he can do is to take a particular interest in a few items and a more general interest in some of the others—if time permits between his chance meetings with old acquaintances!

The thirty-first Exhibition was, if possible, even better than its predecessors, and the exhibition committee and officers of the Physical Society are again to be congratulated most heartily in the well-merited success of their annual effort.

ACTION OF MUSTARD GAS (ββ′-DICHLORODIETHYLSULPHIDE) ON NUCLEOPROTEINS

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EARLY studies on the reactivity of mustard gas (ββ′-dichlorodiethylsulphide) with amines and amino-acids[1,2,3] provided the first indication that its vesicant action might depend on a combination with protein constituents of the living cell. Additional indirect support for such a view was the observation that respiratory and glycolytic processes of bacteria[4] and of minced tumour tissue[5] were inhibited by mustard gas *in vitro*, and that with the sulphone analogue there was inhibition of metabolism of brain tissue *in vitro*, representing a selective effect on the pyruvate oxidase system[6]. Actual evidence that mustard gas could combine with proteins became available when serum proteins were shown to acquire new antigenic properties after treatment in the cold with mustard gas[7].

The antigenic change in serum proteins seemed too feeble, however, to account for the striking biological effects of mustard gas *in vivo*. It seemed desirable, therefore, to repeat the work, using skin proteins instead of serum proteins as test material. Preliminary experiments of this kind yielded, however, unexpected results.

A crude aqueous extract of rabbit skin, when shaken with mustard gas, developed a bulky protein precipitate, having a high sulphur content (thus indicating a combination of the protein with the mustard gas), and a high phosphorus content (suggesting that it was nucleoprotein in type). When a more purified preparation of nucleoprotein, derived from calf thymus, gave similar precipitation with mustard gas, while a number of other proteins failed to give this reaction, the originally planned (immunological) work was set aside, and the precipitation phenomenon investigated in greater detail.

Preparation of extracts: Finely minced tissue (skin or thymus) was extracted first with distilled water, and then with several lots of dilute borate buffer at *p*H 8·5. After removal of insoluble matter by

centrifuging, the pooled solutions were brought to *p*H 6·0 with dilute acetic acid, and the resulting precipitate separated by centrifuging, and dissolved in 0·05 *N* ammonia. This was filtered repeatedly through the same filter paper until clear. (This filtration, which lasted several days, was carried out at 3° C.) The clear filtrate was desiccated by lyophilic drying, and the powder extracted in a Soxhlet apparatus with light petroleum (b.p. below 40° C.). Other methods of extraction yielded preparations which reacted essentially in the same way when treated with mustard gas, and need not, therefore, be described here in detail.

The powder was readily soluble in alkaline solutions at and above *p*H 7·5. On acidification to below *p*H 6·5, a precipitate was formed, which dissolved again on re-addition of alkali. An analysis of the powder gave the following values: 12·2 per cent N; 0·89 per cent P; and 1·1 per cent S. (The nitrogen content of nucleoproteins is usually given as about 16 per cent. The somewhat lower value given above is attributable to a relatively high ash content of the test sample.)

Treatment with mustard gas: In the standard test, 0·5–1·0 per cent of nucleoprotein preparation in *M*/20–*M*/4 borate buffer at *p*H 9·0 was continuously shaken with 1 per cent mustard gas per volume of solution, at 37° C. The *p*H of the mixture was adjusted every few minutes, with small additions of dilute sodium hydroxide (using an external indicator), to neutralize the hydrochloric acid liberated from hydrolysis of mustard gas.

Precipitation occurred whether crude or purified preparations were used, or whether these were derived from rabbit skin or calf thymus. (For negative results in concentrated phosphate buffer, see below.) The precipitation began within 2–5 minutes, becoming first noticeable as a turbidity, which failed to clear on further addition of alkali.

Influence of pH: Maximum precipitation occurred in borate buffer at *p*H 8·5–9·0, falling off considerably at *p*H 9·5, and no longer occurring at *p*H 10·0. In phosphate buffer between *p*H 8·0 and 9·0, only slight precipitation occurred. In acetate buffer, from *p*H 6·5 downwards, the normal precipitation (due to acid *p*H itself) became converted into an irreversible precipitation, after shaking with mustard gas (that is, the precipitate failed to re-dissolve on addition of alkali).

The poor precipitation in phosphate buffer was traced to the relatively high competition factor[9] of phosphate ions for mustard gas in the reaction mixture. (This possible mechanism was suggested to us by Mr. J. St. L. Philpot.) Thus, more precipitate developed with mustard gas in a mixture of borate and acetate buffer at *p*H 8·2 than in phosphate buffer at the same hydrogen ion concentration, while no precipitate developed when the concentration of the phosphate buffer was raised to three molar.

Variation in the concentration of reagents: By varying the concentration of nucleoprotein in the test mixture, corresponding differences were obtained in the yield of precipitate, from a bulky precipitate with 1·5 per cent to a mere trace of turbidity with 0·001 per cent. Diminution in precipitation with decreasing amounts of mustard gas (acting on 1 per cent nucleoprotein) followed a more rapid course, from bulky precipitate with 1 per cent mustard gas to turbidity with 0·05 per cent. This was accounted for by the large proportion of mustard gas becoming hydrolysed before being able to act on the nucleoprotein.

Acid effect in mustard gas precipitation: Though the precipitate produced by acid is reversible (that is, it redissolves on addition of alkali) whereas that produced by mustard gas is irreversible, it seemed possible that during the hydrolysis of mustard gas, the acid *produced at the actual point of liberation* might be sufficiently concentrated to cause denaturing of the nucleoprotein. This was excluded by the following tests:

1. Mustard gas and nucleoprotein tested in strongly buffered solution, with frequent adjustments of *p*H and vigorous shaking, so that the maximum fall in *p*H was never more than 0·5: precipitation occurred as usual.

2. Small amounts of concentrated hydrochloric acid, instead of mustard gas, added to a buffered nucleoprotein solution: no irreversible precipitation.

3. Other compounds, known to liberate hydrochloric acid through hydrolysis (see below), tested on nucleoprotein solutions: of these, lewisite, dichlorodimethylsulphide, and *t*-butyl chloride, failed to produce irreversible precipitation.

4. Estimation of sulphur content of nucleoprotein before and after treatment with mustard gas (uncombined mustard gas being removed by extraction of the precipitate with lipoid solvents): sulphur content of acid-precipitated nucleoprotein ranged from 1·1 to 1·7 per cent; sulphur content of treated nucleoprotein with mustard gas ranged from 1·8 to 3·3 per cent, the higher figures being obtained in tests with prolonged treatment with large excess of mustard gas.

Effect of mustard gas on other proteins: Similar tests to the above were made on serum globulin, serum albumin, fibrinogen, prothrombin, hæmoglobin, gelatine, pepsin, and ribonuclease. In the standard tests (lasting 20 minutes) no precipitates developed (except with hæmoglobin, which was accounted for by non-specific precipitation resulting from prolonged shaking).

The tests were repeated for longer periods, with the mustard gas added in divided doses (1 drop to 30 ml. of test mixture every 15–20 minutes) and the amounts of precipitate estimated nephelometrically in a 'Spekker' photo-electric absorptiometer: no effect was observed with ribonuclease; slight turbidity only with pepsin, gelatine, albumin, prothrombin and fibrinogen (the last-mentioned being non-specific, due to shaking); progressively increasing precipitation with globulin, though very much more slowly than with nucleoprotein.

Nucleoprotein precipitation in vivo: If the nucleoprotein inside the living cell became irreversibly denatured following mustard gas application, the amount of soluble nucleoprotein extractable from such tissue should be greatly reduced. This was investigated.

Some neat mustard gas was applied to a large area of skin on rabbits, and two hours later (by which time erythema and œdema were well pronounced) the treated skin, as well as neighbouring normal skin for control, were excised and extracted by the method described above: no detectable nucleoprotein was obtained from the treated skin, whereas the normal skin yielded abundant quantities. When tested at shorter intervals (½–1 hour) after application, some nucleoprotein was extractable from the treated skin, though in greatly diminished amounts compared with the normal skin.

At the suggestion of Dr. R. H. S. Thompson, these tests were repeated on rat skin, using much smaller quantities of mustard gas (for example, 1 drop of a 5 per cent solution in ethanol, an amount known to be just sufficient to produce œdema, and to interfere with enzymic activity of the skin): under these conditions, apparently normal yields of nucleoprotein were obtained from the treated skin (any precipitation that may have occurred being too small to be detected by the semi-quantitative method of comparison used).

Effect of other compounds on nucleoprotein: This investigation, forming part of a separate study, gave results of interest in connexion with the present work, and may be summarized as follows: similar precipitation of nucleoprotein was obtained with a few compounds closely related chemically to mustard gas, all possessing strong vesicant action. On the other hand, lewisite gave no precipitation. In the case of ββ′-dichlorodiethylsulphone and of divinylsulphone, no actual precipitation occurred, but the precipitate formed on acidification (subsequent to the treatment with these compounds) failed to re-dissolve on addition of alkali. (These last results need confirmation on other samples of nucleoprotein.)

Dichlorodimethylsulphide (an analogue of mustard gas, almost non-vesicant, but hydrolysing rapidly in water), also *t*-butyl chloride, and other related compounds, produced no precipitate when shaken with nucleoproteins.

Though conclusions from *in vitro* tests with purified proteins must be accepted with caution, since the 'purification' may have contributed towards the effects produced, the observation that nucleoproteins are rapidly precipitated by mustard gas is rendered significant by the fact that after treatment of skin with mustard gas *in vivo*, no soluble nucleoprotein is any longer extractable. The formation of an insoluble nucleoprotein-mustard gas compound cannot, therefore, be attributed to the use of partially denatured nucleoprotein, but represents a product of interaction which bears some relation to the action of mustard gas on living cells.

As evidence that mustard gas can combine with proteins, these findings support the previous results from immunological studies[7], and are in keeping with the more recent results with corneal collagen[9], keratein[10], various proteins, using mustard gas with radioactive sulphur as tracer[11], egg albumin, casein, and amino-acids[12]. (Reference should also be made to the observed interaction between 'nitrogen mustards' and sodium thymonucleate, etc.[13])

However, unlike the compounds formed by mustard gas with other proteins, that formed with nucleoprotein is highly insoluble. Such specific precipitation *in vivo* may produce special effects, for in failing to precipitate cytoplasmic proteins, mustard gas might be able to penetrate the nucleus and produce characteristic changes there. In this connexion, it may be noted (*a*) that the lethal effect of mustard gas on cells is delayed for several hours, as with X-rays, but unlike most other irritants, and (*b*) that mustard gas also behaves like X-rays in producing mutations in *Drosophila melanogaster*, while other irritants (including lewisite) do not[14].

Intra-nuclear precipitation of nucleoproteins could only represent one aspect of the biological action of mustard gas. Apart from the cytoplasmic nucleoproteins, associated with mitochondria, microsomes, etc., there are enzymes of nucleoprotein type (for example, the flavoproteins) in the cytoplasm, precipitation of which would seriously interfere with function. Furthermore, combination of proteins (or other important cell constituents) with mustard gas, *without precipitation*, would also lead to important changes in living cells.

Recent evidence points to a multiple mechanism of vesicant action, and the present results lend further support to this view. Some of the local effects are more likely to be associated with interference with enzyme action in the cell[15], while the hypersensitivity which may develop after repeated exposure is more readily explained on the development of antigenically changed proteins[7]. Nevertheless, in view of the important role which nucleoproteins have in the living cell, their irreversible precipitation *in vivo* is likely to have serious consequences, and may well be largely responsible for the necrotizing effects in mustard gas burns.

This work was carried out in 1940 as part of a programme of extramural research for the Ministry of Supply, and communicated to the Ministry in 1940. We wish to thank Prof. R. A. Peters and other members of the group working in this field in Oxford, for helpful advice, and the Director of Scientific Research (Defence), the Ministry of Supply, for permission to publish these results.

[1] Clarke, *J. Chem. Soc.*, **101**, 1583 (1912).
[2] Cashmore and McCombie, *J. Chem. Soc.*, **123**, 2884 (1923).
[3] Lawson and Reid, *J. Amer. Chem. Soc.*, **47**, 2821 (1925).
[4] Jany and Sellei, *Biochem. Z.*, **275**, 234 (1935).
[5] Berenblum, Kendal and Orr, *Biochem. J.*, **30**, 709 (1936).
[6] Peters, *Nature*, **138**, 327 (1936).
[7] Berenblum and Wormall, *Biochem. J.*, **33**, 75 (1939).
[8] Ogston, Holiday, Philpot and Stocken, Report to Ministry of Supply (1941).
[9] Pirie, Report to Ministry of Supply (1941).
[10] Peters and Wakelin, Report to Ministry of Supply (1941).
[11] Banks, Boursnell, Francis, Hopwood and Wormall, *Biochem. J.*, **40**, 745 (1946).
[12] Hartwell, *J. Nat. Cancer Inst.*, **6**, 319 (1946).
[13] Gjessing and Chanutin, *Cancer Res.*, **6**, 593 (1946).
[14] Auerbach and Robson, *Nature*, **157**, 302 (1946).
[15] Dixon and Needham, *Nature*, **158**, 432 (1946).

STRUCTURE AND PROPERTIES OF DIAMOND

THE diamond offers a variety of fascinating problems to the research worker interested in the correlation of physical properties with crystal structure, and the well-known variations of crystalline habit, colour, fluorescence, and so forth, are responsible for a bulky scientific literature. Its scientific interest and its beauty as a gem inspired many abortive attempts at synthesis, and probably one successful solution of the problem[1]. It is not surprising that the diamond was among the very first crystals examined by X-ray methods, and the essential simplicity of the structure is in striking contrast with the complexity revealed by a detailed examination of the crystalline form and properties.

The researches of Robertson, Fox, and Martin, published in 1934[2], established firmly the existence of two kinds of diamond, known as Type I and Type II for lack of clear understanding of the origin of the observed differences in various physical properties. Since that time, much experimental data has been obtained by X-ray methods in the Davy

Faraday Laboratory, London, and it is now at least possible to show in what respects the X-ray diffraction effects characteristic of diamonds of Types I and II are *not* explicable in terms of theories which cover phenomena observed with other crystals. A very large amount of interesting experimental work has also been reported in publications from the Indian Institute of Science at Bangalore, especially in two symposia[3,4] on the "Structure and Properties of Diamond". The team at Bangalore, under the direction of Sir C. V. Raman, originally directed attention to anomalies in X-ray scattering, and has more recently applied a variety of physical methods to the examination of a very fine collection of diamonds. The earlier work (particularly that on diffuse X-ray reflexions) served as the basis for the development, by Raman[5], of a general theory of the dynamics of the crystal lattice which has been strongly criticized by theoretical and experimental workers[6] and has not found acceptance in other laboratories than that at Bangalore. Later, in order to provide a structural interpretation of experimentally observed variations in physical properties and growth habit, Raman[3] advanced a theory of the symmetry of diamond which implies the existence of four different crystal structures. Raman's exposition and development of this theory were much less obscure than in the case of the general theory of the crystal lattice, but its application to X-ray diffraction effects has been criticized very severely[7], and again it must be admitted that acceptance is withheld, outside the Bangalore laboratory.

It is against this background that the second symposium on the structure and properties of diamond[4], here under review, must be judged. The style and general content of the twenty-one papers, all contributed by Raman and his collaborators in the Bangalore Institute, show no serious departure from those of previous publications from this school of research; the treatment is in many cases descriptive rather than analytic, and, in the reviewer's opinion, the value of the observational data is reduced rather than enhanced by the insistence with which they are adduced in support of the Raman theories, and stated to be in flat opposition to others. This treatment succeeds only in conveying the impression, whether rightly or wrongly, that the Raman theories dominate the experimental researches of the Bangalore school to an extent which must encourage an uncritical acceptance of interpretations favouring Raman's views, while adverse criticisms of the Raman theories, expressed by other workers in this field of research, remain unrefuted. In the review which follows, therefore, no attempt is made to assess the theoretical significance of the new experimental data.

Crystalline Form and Microscopic Structure

In the first of four papers on topics which may be grouped under this heading, Raman and Ramaseshan (pp. 1–24) develop the idea that the curved faces and edges which frequently occur in natural diamonds are not accidental features of growth, as is commonly supposed, but represent essential properties of the crystal. On this view the curved faces appear as a direct consequence of the act of solidification from a drop of liquid carbon, while the edge-development gives the clue to the true internal symmetry of the structure; the majority of the seventy-two diamonds examined are classified, in this way, as showing tetrahedral symmetry, though truly octahedral symmetry is established in some cases and interpenetration of positive and negative tetrahedral forms is frequent. A semi-quantitative elaboration, by Ramaseshan (pp. 122–129), of the suggestion that curvature of the faces corresponds directly with curvature of the liquid drop of carbon, requires the *ad hoc* assumption that a high degree of directed valency-bonding exists before solidification. The calculations of crystal surface energies are correlated with cleavages in another paper by Ramaseshan (pp. 114–121); but it is perhaps not unreasonable to suggest that these calculations, and the deductions drawn from them, may represent an over-simplification of the very complex energy problems associated with crystal growth and face-development under conditions and in an environment of which little or nothing is known. For their bearing on these views as to the significance of curved faces and edges, the recent experimental observations of Tolansky and Wilcock[8] are of great interest; it seems that the multiple-beam interference technique establishes beyond any reasonable doubt that these features of the topography of the diamond are due to the deposition of a succession of stepped growth-sheets —a mode of crystal growth commonly observed in other substances.

A paper by Ramachandran (pp. 65–80) describes in detail the dimensions, orientation, and optical characteristics of the laminated structures seen under optimum conditions in many diamonds of Types I and II, and attributes the positive and negative uniaxial characters of the laminæ to states of compression and tension arising from variations in lattice-spacing in the different kinds of diamond structure postulated by the Raman theory. The real existence of such variations in spacing, reported by R. S. Krishnan[3], has, however, been denied by Lonsdale[7], so that the validity of Ramachandran's interpretation of his observations is open to question.

X-Ray Studies

Studies by R. S. Krishnan (pp. 33–44) and by Ramachandran (pp. 95–103) represent the extension and refinement of researches already reported, the former on the temperature-variation of lattice-parameter, the latter on X-ray topography, with an attempt to correlate variations in X-ray reflecting power with the laminations observed optically and with luminescence phenomena.

In a theoretical study, Ramachandran (pp. 58–64) calculates the X-ray diffraction effects to be expected for a diamond structure in which carbon atoms occupy the sites 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ in the cubic unit cell, but are assumed to have non-spherically symmetrical electronic configurations. He concludes that it is impossible from the presence or absence of the (200) and (222) reflexions to decide uniquely whether the symmetry of the crystal is tetrahedral or octahedral. He states, however, that "the (222) reflection is . . . absent only in the fully antisymmetric case", which (if the reviewer has understood Ramachandran's nomenclature correctly) is equivalent to saying that the (222) reflexion is absent only when the two carbon atoms at 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ are identical and have identical orientations, a requirement of the tetrahedral structure. Lonsdale[7] has shown that a real (222) reflexion exists, which would appear, on Ramachandran's own calculations, to prove that the symmetry is octahedral.

Atomic and Electronic Vibrations

The greater part of the symposium is devoted to the observation of optical properties and their interpretation in terms of atomic and electronic vibrations.

Precision measurements are included in six papers, of which two by Krishnan (R. S.) (pp. 25–32 and 45–57) report observations of the second-order Raman spectrum and its variation over a wide range of temperature. Ten distinct second-order lines have frequencies corresponding with infra-red absorption maxima, and five of them are octaves of the frequencies assigned in the Raman theory to lattice vibrations. It is difficult to attach any real significance to the proposed interpretation of the Raman spectra, when Krishnan persists in associating the octave of the fundamental Raman frequency 1332 cm.$^{-1}$ with the steepest point in the curved line joining an infra-red absorption maximum with the adjacent minimum—an arbitrary proceeding already condemned by Sutherland[9]. On the purely experimental side, however, it is to be noted that a recent communication in *Nature*[10] by Krishnan reports the complete resolution of the Raman lines, which in the symposium appear only as minute 'steps' on a continuous faint background.

Four papers by Ramanathan (pp. 130–161) describe infra-red, visible, and ultra-violet absorption properties of a large number of diamonds, and demonstrate that it is not possible to draw a definite line of demarcation between Type I and Type II diamonds from observations on infra-red absorption near 8 μ and ultra-violet absorption near 2250 A.

Descriptive accounts of the luminescence exhibited by diamonds under various stimuli occupy no fewer than five papers, and Ramachandran (pp. 81–94) outlines a semi-quantitative theory of the luminescence due to X-ray excitation. In a short review it is possible to do no more than indicate some of the effects described and discussed in papers by Rendall (pp. 168–175), Chandrasekharan (pp. 182–197), Ramachandran and Chandrasekharan (pp. 176–181); they include the blue and yellow fluorescence patterns, phosphorescence which persists for a short time after cutting off the exciting radiation, thermoluminescence observed on heating to 270° C., and the deactivation effect of radiation of wave-length longer than 4200 A., which causes a 'flash' emission of visible light. In the last of the papers listed above, Ramachandran and Chandrasekharan bring some evidence in support of their suggestion that luminescence effects are due to 'forbidden' electronic transitions.

Conclusion

The symposium includes also papers by Ramaseshan (pp. 104–113) on the Faraday effect and by Achyuthan (pp. 162–167) on photoconductivity, both largely experimental.

Many of the experimental data recorded in this substantial volume of about 200 pages, illustrated by many plates and drawings, are of great interest, actual or potential. The attempted interpretation of these data, however, in terms of the Raman theories, cannot be convincing unless the criticisms already made by workers outside the Bangalore Institute are answered in full and in such a way as to satisfy the critics. Instead, the Bangalore workers would sometimes seem to turn to fresh experimental approaches in the search for further support for their theories, leaving the original criticisms unanswered. The inevitable result is that full recognition is withheld from what is obviously an enthusiastic and hard-working research team, engaged on a problem of great interest and importance.

W. H. TAYLOR

[1] Bannister, F. A., and Lonsdale, K., *Nature*, **151**, 334 (1943).
[2] Robertson, R., Fox, J. J., and Martin, A. E., *Phil. Trans. Roy. Soc.*, A, **232**, 463 (1934).
[3] (First Symposium) *Proc. Indian Acad. Sci.*, **19**, A, 189 (1944). See also Preston, G. D., *Nature*, **155**, 69 (1945).
[4] (Second Symposium) *Proc. Indian Acad. Sci.*, **24**, A, 1 (1946).
[5] Symposium on the Quantum Theory of X-Ray Reflection, etc., *Proc. Indian Acad. Sci.*, **14**, 317 (1941).
[6] See, for example, Born, M., Lonsdale, K., and Smith, H., *Nature*, **149**, 402 (1942).
[7] Lonsdale, K., *Nature*, **155**, 144 (1945).
[8] Tolansky, S., and Wilcock, W. L., *Nature*, **157**, 583 (1946).
[9] Krishnan, R. S., and Ramanathan, K. G.; and Sutherland, G. B. B. M., *Nature*, **157**, 45, 582 (1946).
[10] Krishnan, R. S., *Nature*, **159**, 60 (1947).

OBITUARIES

Sir Almroth Wright, K.B.E., C.B., F.R.S.

ALMROTH EDWARD WRIGHT was born in Yorkshire in 1861, the second son of the Rev. C. H. H. Wright, a distinguished Ulster divine, by his wife Ebba, daughter of Nils Almroth, governor of the Swedish Royal Mint. He was educated at first in Germany and France and then privately in Belfast before going up to Trinity College, Dublin, where he graduated B.A. in 1882 and M.B., B.Ch. in 1883, proceeding to the M.D. degree in 1889. After working at the Universities of Leipzig, Strasburg and Marburg, he returned to England to become demonstrator in pathology in the University of Cambridge, where he took the B.A. degree in 1888. In 1889 he became demonstrator in physiology in the University of Sydney, returning three years later to become professor of pathology at the Army Medical School at Netley, where he remained until 1902.

Following up the tentative essays of Pasteur, Haffkine and Pfeiffer, Wright originated in 1896 the system of anti-typhoid inoculation. The results of this prophylactic measure in South Africa and India were so striking that before the outbreak of the First World War it had been made standard practice in the British Army. In 1898 Wright went to India as a member of the Plague Commission. In 1902, following differences with the War Office about anti-typhoid inoculation, he resigned his professorship at Netley and became pathologist to St. Mary's Hospital, London. Here he founded the Inoculation Department, of which he was the first principal. Here, too, he originated the system of therapeutic inoculation for bacterial infections (vaccine therapy) and numerous methods for measuring the protective substances in the blood, notably the opsonic index. He held also a professorship of experimental pathology in the University of London.

In 1914 Wright published the results of his investigations into the incidence, prevention and treatment of pneumonia among the natives employed in the South African mines.

During the First World War, Wright served as consulting physician to the British Forces in France, and devoted himself to studying the immunology of wound infections and to combating the ravages of gas gangrene. This was his last great research.

By 1925, all Wright's important contributions to bacteriology and immunology had been made. He worked as assiduously and devotedly as ever, but in unpropitious circumstances. All the problems sus-

ceptible of solution by the methods which Wright had devised and of which he was an acknowledged master had been solved, and the questions awaiting solution could be attacked only by new methods and a new approach. Moreover, the team which he had trained, inspired and led, and which had contributed in no small measure to his triumphs, had disintegrated: some had turned from immunology to other subjects; some had sought greater scope and brighter prospects elsewhere. Other pupils and assistants he had, but times had changed, and they lacked the faith and industry of their predecessors; and, having set their hands to the plough, sooner or later turned back.

In these circumstances, Wright tended to direct his attention more and more to philosophy and, in particular, to logic. The subject had always fascinated him and, as early as 1895, he had contributed to *Brain* a paper "On the Nature of the Physiological Element in Emotion". This contribution he afterwards had reprinted to "demonstrate that some of the problems treated of in this Book have been actively simmering in my mind for at least fifty years". He determined, then, now that opportunity offered, to produce a book of technique for the abstract thinker which should do for him what his book "The Technique of the Teat and the Capillary Glass Tube" had done for the laboratory worker. He felt the inadequacy of formal logic and the sterile ratiocinations of the Schoolmen, of which he says: "And if we were dealing with a syllogism, there would in every case be something which rendered it non-coercive—I am thinking of the fact that we are never in a syllogism given convincing evidence that the major and minor premises can be safely accepted". He proposed to supplement syllogistic induction by a series of criteria of truth, which could be applied to logical propositions as the crucial experiment is applied to physical phenomena. This project, in the course of time, assumed many forms and underwent many vicissitudes, to emerge finally as "Alethetropic Logic, or the Logic which searches for Truth", of which the preliminary volume, "Prolegomena to the Logic which searches for Truth", had appeared in 1941. To this book, which Wright regarded as his *magnum opus*, he was putting the finishing touches: in fact, he was working upon it within a few hours of his death on April 30.

What manner of man was Wright? His intellect, naturally commanding, had, by wide reading, extensive travel and profound reflexion, become a precision instrument of the finest quality. It absorbed and assimilated with equal facility science, literature, law and philosophy, and made him, without apparent effort, a brilliant public speaker and a delightful conversationalist. His place as a pioneer worker and original thinker is assured. But he used his great gifts naturally and without ostentation, so that no one, were he never so young or so unsophisticated, was ever abashed or discomfited in his presence. In controversy, although he loved it, he was not at his best; and gave sometimes a totally erroneous impression of his character and intelligence. On matters of principle he was steadfast and unyielding, but in argument he often appeared elusive and even disingenuous, so that such verbal engagements were usually unsatisfactory and indecisive.

The outstanding trait in Wright's character was his kindliness. No one ever appealed to him in vain for help of any kind, and many were the beneficiaries of his secret munificence. The sight of suffering always affected him profoundly, and this compassion was a spur that ever urged him on. Other endearing traits he had in plenty: great personal charm and an impish sense of humour, unwearying patience and a temper either naturally equable or under complete control, undaunted pertinacity and an equanimity which neither failure nor success could shake.

It is customary, when writing of a great man, to say that we shall never see his like again; but this is literally true of Almroth Wright, for while heredity might play its part in producing his peer, the environment, in which alone so bold, fearless and uncompromising a spirit could flourish and attain full stature, has passed away. R. T. MUMMERY

Prof. Heinrich Kayser, For.Mem.R.S.

WAR conditions led to the fact that the death of Heinrich Kayser on October 14, 1940, at Bonn at the age of eighty-seven passed unnoticed in Great Britain.

Born at Bingen on March 16, 1853, Kayser was educated at the Sophieen Gymnasium in Berlin and at the University of Strassburg under Kundt; there one of his fellow students was Röntgen. He took his doctorate at Berlin and became an assistant to Helmholtz in 1879. He was introduced to spectroscopy in 1880 by Hagen, one of his fellow assistants, and at once became drawn to the subject, publishing his "Lehrbuch der Spektralanalyse" in 1883. In 1885 he was appointed to the Technische Hochschule in Hanover, where he had as his colleague Runge, and as assistant Paschen. The nine years at Hanover, before he succeeded Hertz at Bonn, were very fruitful in tables of the spectra of the different elements, of which the best known was the photographic map and table of wave-lengths for the spectrum of the iron arc from 2500 to 6600 A., published in collaboration with Runge.

The work on which Kayser spent most of his twenty-five years at Bonn—his life-work—was the "Handbuch der Spectroscopie", of which the sixth volume came out in 1912. It was a stupendous undertaking, a compendium of all that was known in spectroscopy. The subject had grown so much while the work was in progress that the proposed volume on astrophysical applications got squeezed out, and two supplementary volumes were needed and brought out with the aid of Konen and others after Kayser had passed the age of eighty. Other valuable contributions in his later years included a "Tabelle der Hauptlinien der Linienspektren aller Elemente"; but the "Handbuch" remains as his monument.

Kayser's wide knowledge of languages was a great help to him in his work and was combined with a passion for travel, in part inherited from his parents. He was one of the founders of the International Solar Union in 1904 and attended its meetings regularly; he was the genial host at Bonn for the meeting in 1913. Though he was one of the first to be co-opted, when that became possible, on to a commission of the International Astronomical Union, that of Standard Wave-lengths, he never attended its meetings. He was elected a foreign member of the Royal Society in 1911 and was present and spoke at the two hundred and fiftieth anniversary gathering in 1912; of this meeting he said in his autobiography, written at the age of eighty-three: "Uberall zeigt sich als alteingewurzelt Tradition, Reichtum, Macht; und das wirkt mehr als alle Reden".

F. J. M. STRATTON

Dr. J. D. Falconer

Dr. John Downie Falconer, geologist and geographer, died at Hounslow on April 16. The news of his death came as a shock to his friends, since he was present, and in apparent good health, at the annual meeting of the Geological Society just a month before.

Falconer was born in Midlothian in 1876 and was educated at the Universities of Glasgow and Edinburgh. During 1901–4 he was assistant to Prof. James Geikie, and he then went to Northern Nigeria as principal of the Imperial Institute Mineral Survey, returning to the University of Glasgow to take up the appointment of lecturer in geography in 1911. He went back to Northern Nigeria in 1916 as an assistant district officer, but in 1918 he was made director of Geological Survey for Nigeria, a post he held until 1927. During 1928–34 he was geologist to the Republic of Uruguay.

Dr. Falconer was the author of many papers and official bulletins, and of works in lighter vein on his travels in Nigeria and Uruguay. In 1937 he published a book on Darwin in Uruguay. The work for which he is best known and will long be remembered with appreciation is that relating to the physiography, geology and mineral resources of Nigeria, the results of which are in part incorporated in his "Geology and Geography of Northern Nigeria". This book and the accompanying map remain a valuable source of information, and the theoretical discussions, while not always in accord with modern views, have served as a great stimulus to further investigation. His work was characterized by thoroughness and wide knowledge of his subject, and it stands as a tradition and an inspiration to the Geological Survey of Nigeria, of which he was the first director. He was responsible for the earlier issues of the bulletins of the Geological Survey of Nigeria and the accompanying geological maps, which were of considerable scientific and economic value, especially as regards the tin resources of Nigeria.

The Geological Society awarded Dr. Falconer the Lyell Fund in 1920, and he served on the Council of the Society during the period 1927–29.

His loss is deeply felt by many friends and former colleagues, and by the mining community of Nigeria.

F. Dixey

Prof. Fritz Weigert

The death of Prof. Fritz Weigert on April 13 was a loss to science, and came as a sad blow to a wide circle of friends and colleagues who admired him as much for his personal charm and wide culture as they respected him for his academic achievements.

Fritz Weigert was born in Berlin in 1876, where he received his education as a chemist. While his early collaboration with such men as van't Hoff and Nernst in Berlin and Robert Luther in Leipzig no doubt had a profound influence on his life-work, the originality and highly individual character of his subsequent researches in photochemistry and related fields must be attributed to his own peculiar gifts, both in the brilliant improvisations of technique and in his imaginative approach in the interpretation of results and formulation of new theories.

In 1914 he was appointed professor of photochemistry at Leipzig, in succession to Luther, and in his inaugural lecture he put forward the courageous, if unorthodox, suggestion that in a new field of research (as the study of photochemical reactions then was), rigid systems of interpretation, even if afterwards proved to be wrong, are justified on the grounds that new experimental methods may thereby be disclosed and new angles of approach discovered, which would be a stimulus for further research. In Weigert's hands, this double-edged weapon undoubtedly bore rich rewards in his researches, though it may also have been in part responsible for the tardiness in acknowledging all the credit due to him.

After thirty years of research in physical chemistry in Germany, Fritz Weigert had, with the advent of Nazism, to seek refuge in a foreign land; and so began his second career, at the age of sixty, as director of the Physico-chemical Department of the Cancer Research Institute, Mount Vernon Hospital, at Northwood, Middlesex. It is hard to say whether the choice of cancer research was entirely dictated by circumstances, or whether it was not partly influenced by his heritage, for he was the nephew of two of the most distinguished pathologists of the last century—Paul Ehrlich and C. Weigert.

The study of the metabolism of the carcinogenic hydrocarbon, 3:4-benzpyrene, by the application of fluorescence spectrography, which Weigert undertook in his new position, was ideally suited for a man of his ability, and he threw himself into the problem with the energy and enthusiasm that a man half his age might have envied. His contributions to this field were significant and stimulating, and characteristic of the man, both in the sphere of technique (as in his adaptation of fluorescence spectrography for the study of hydrocarbons adsorbed on alumina columns) and in the realm of interpretation of results.

Fritz Weigert was, to the end, a keen and active worker, and, despite his deafness, a witty and lively conversationalist. His death was unexpectedly sudden, as he himself would no doubt have wished it to be.

I. Berenblum
H. von Halban

Alice Lady Avebury

The death of Alice Lady Avebury at High Elms, Downe, Kent, on March 11, at the age of eighty-five, removed an important link between the two leading prehistorians of the Victorian period. She was the daughter of General Pitt-Rivers and the wife of the first Lord Avebury. From her father she inherited much—his clear intellect, his orderly ways and his imperious manner. She was Lord Avebury's second wife, being married to him in 1884 while he was still Sir John Lubbock, member of Parliament, banker, author of "Prehistoric Times" and the father of Bank Holidays. The Lubbock home, at High Elms, was a centre where the celebrated men of science of the Victorian period came to spend week-ends. Lady Avebury was an ideal hostess, and around her many new friendships were formed. She was a woman of wit and of beauty, never afraid to give utterance to what she really thought and believed. She was on the most friendly terms with the Darwin family at Down House, and when Darwin's home passed into the custody of the British Association she continued her association with that remarkable place. She welcomed the transfer of the historic Lubbock home of High Elms with its park and woods to London's Green Belt; indeed, she took the initiative in this transfer. Her daughter, the Hon. Mrs. Ursula Grant Duff, continues the Avebury interest in social science.

Arthur Keith

NEWS and VIEWS

Prof. Carl Størmer

On May 20 the University of Oxford conferred the degree of D.Sc., *honoris causa*, upon Prof. Carl Størmer, who later on the same day delivered the Halley Lecture on "Polar Aurora in Southern Norway". The presentation speech by the Public Orator at the degree ceremony was in Latin elegiac verse, with a prose addendum which included the remark that Prof. Størmer richly deserved a gown equally worthy of the Goddess of Dawn and the Goddess of Learning. The verse described an imaginary interview between the Public Orator and the Goddess Aurora, who was visible (so it seemed) in the northern skies at night during the recent hard weather, and appeared to have deserted her usual haunts and her husband Tithonus. Aurora bade the Orator to improve his knowledge of celestial phenomena (and his opinion of her) by consulting the eminent Norwegian astrophysicist Prof. Størmer, whose pride it was to have mastered the nature of her counterfeit, the Aurora Polaris, determining the situation, form, motion and spectrum of this phenomenon. He could also speak with authority on the 'mother of pearl' clouds high in the stratosphere, and in addition had long studied the motion of charged particles arriving at the earth from the sun.

Prof. Størmer, now emeritus professor of pure mathematics at the University of Oslo, besides making distinguished contributions to that subject, and applying it to the study of the motion of charged particles in the earth's magnetic field, thus explaining many remarkable observed characteristics of the Aurora Polaris, has for more than a third of a century been the foremost leader and organiser of auroral observation by simultaneous photography from two or more well separated stations in Norway. This work has brought a rich harvest of increased knowledge of the Aurora Polaris, presenting a fascinating set of problems for theoretical geophysicists. As by-products of his observing organisation, Prof. Størmer has also made important additions to our knowledge of 'mother of pearl' clouds and of winds in the upper atmosphere, as indicated both by such clouds and by meteor trails.

British Rubber Producers' Research Association: Dr. Geoffrey Gee

Dr. Geoffrey Gee, who has recently been appointed director of the British Rubber Producers' Research Association's extensive laboratories at Welwyn, has made important contributions to our knowledge and understanding of the properties of long-chain polymers, especially rubber. His early work at Cambridge dealt with the kinetics of polymerization reactions both in bulk and at interfaces. More recently, he has undertaken a critical examination of the thermodynamics and statistical mechanics of systems involving rubber and related polymers. The last decade has witnessed striking advances in the mathematical treatment of the behaviour of long-chain molecules, but there has been a dearth of exact experimental data, thus precluding any development of the statistical mechanical treatment. Dr. Gee with his collaborators has been able to provide reliable and extensive experimental data which have permitted them in turn to make advances in the theoretical treatment. The determination of the molecular weights of rubbers and the inter-relationship of the different methods; the connexion between the heats of mixing of rubber and liquids and their cohesive energy densities constitute two of the more important sections of his work.

Sir Edwin Ray Lankester (1847–1929)

The greatest morphologist of his generation, Sir Edwin Ray Lankester was born a century ago, on May 15, 1847. He was the son of a medical man, he taught medical students, and throughout his career delighted in making zoology serve medicine. When he graduated at Oxford in 1870, biology was still regarded as an apanage of medicine. Those desirous of devoting their lives to the pursuit of comparative anatomy, zoology or physiology had to seek a post at a medical school. It was Huxley who urged budding biologists to seek out independent paths for themselves. In 1874, Ray Lankester, then aged twenty-seven, was appointed to the Jodrell chair of zoology at University College, London. In 1891 he became Linacre professor of comparative anatomy at Oxford, returning to London two years later to succeed Sir William Flower as director of the British Museum (Natural History). On his retirement at the age of sixty he was created K.C.B. A tireless worker and a prolific writer, Ray Lankester's individual contributions to zoology were numerous and distinguished; yet he was at home in almost all fields of biological knowledge. A massive yet nimble mind dwelt in a massive frame. Impatient, utterly fearless, sociable, charming, with a deep booming voice, Ray Lankester was one of the most brilliant and imaginative lecturers in British science. He died on August 15, 1929.

Linnean Society of London: Anniversary Meeting

At the anniversary meeting of the Linnean Society of London held on May 24, the president, Prof. G. R. de Beer, announced that a message of congratulation had been addressed to H.M. Queen Mary, honorary member of the Society, on the occasion of her eightieth birthday, and that H.R.H. the Princess Elizabeth had been pleased to accept the honorary membership of the Society. He delivered a presidential address on "How Animals Hold Their Heads". The Linnean Gold Medal was awarded to Prof. Maurice Caullery, of Paris, who was present to receive it. The following were elected officers for the session 1947–48: *President*, Prof. G. R. de Beer; *Treasurer*, Colonel F. C. Stern; *Secretaries*, Dr. Malcolm A. Smith (Zoology) and Dr. B. Barnes (Botany). The new Members of Council were Prof. G. D. Hale Carpenter, Mrs. Vera Higgins, Mr. E. W. Mason, Dr. W. E. Swinton and Dr. George Taylor. The following were elected foreign members: Prof. A. Chevalier, Muséum d'Histoire Naturelle, Paris; Prof. C. M. Child, University of Chicago; Prof. E. Fischer-Piette, Laboratoire de Malacologie, Paris; Prof. E. Hultén, Natural History Museum, Stockholm; Dr. G. G. Simpson, American Museum of Natural History, New York. In addition, W. G. Mackenzie, curator of the Chelsea Physic Garden, and A. W. Stelfox, of the National Museum of Ireland, were elected associates *honoris causa* of the Society. During the proceedings a film entitled "The Development of the Sperm Cells of the Grasshopper" was shown, with a commentary by Dr. C. D. Darlington.

Scientific Research Organisation in Great Britain

In the first A. D. Little Memorial Lecture, "Science, Industry and Government", now published in *Technology Review* (February 1947), Sir Edward Appleton, speaking before an American audience, reviewed British experience in the organisation of research. Success in the organisation of science in the war effort has led the public to conclude that science should play a similar part in solving the problems of peace. Ultimately the provision of work, homes, food, health and safety from aggression for all depend for solution on the maintenance of the same kind of partnership between government, science and industry which grew up during the War; and, referring to the brilliant team-work during the War, Sir Edward pointed out that the result of the policy pursued was that the research establishments of the Services were strengthened by the addition of many brilliant minds from the universities, while the research teams in industry were left intact and ready to attack, as composite units, the problems allotted to them. One of the most striking results of war-time experience in Britain was the brilliant success of university research workers in solving war problems entirely remote from their peace-time interests. University conditions appear to ensure the maintenance of the mental adventurousness and lively imagination so necessary for scientific progress; and in planning the future of the Scientific Civil Service in Britain, an attempt is being made to secure conditions that encourage these qualities.

The most successful applications of science in our war-time experience resulted from the closest possible collaboration between the men of science and the military staff; the field in which the scientific worker can usefully operate extends far beyond the laboratory. Free fundamental research had, however, been almost entirely in abeyance in Britain, and we must recognize the return of peace by changing our priorities. In many fields, we have been living on our scientific capital, which now stands urgently in need of replenishment. Pointing out that scientific research in the universities is of relatively modern growth, Sir Edward referred to the accepted university tradition that teachers of scientific knowledge should also advance that knowledge. Although carried out in a spirit of pure inquiry, this free fundamental research has shown a surprising capacity for being useful. The universities are also the source of the trained scientific workers for university, government and industrial laboratories, and in this connexion Sir Edward referred to the outstanding importance of the exceptional man. Most of the really great advances in science have been accomplished by small teams of workers led by a man with ideas, and Sir Edward believes that a vital task is to see that such men lack neither disciples, assistants nor equipment.

Magnetic Recording of Sound

A lecture on "Developments in Magnetic Recording" was given by Mr. P. T. Hobson to the British Sound Recording Association on March 27, with demonstrations of the wire-recording machine now in production and available in small quantities for non-entertainment purposes. A model of a high-grade instrument shows that the technique of wire-recording has risen so rapidly in recent years that the quality of reproduction obtained can be classed as high, if not higher, than with the best disks and the Philips–Miller system. The comparative cheapness of the wire, the possibility of erasure and the immediate rewind makes magnetic recording attractive for many purposes, apart from the straight and protracted reproduction of music. Ever since Poulsen discovered the possibility of magnetic recording nearly fifty years ago, designers have been misled by the erroneous idea of the exact process of magnetization. Research by the Armour Corporation of the United States and also in Britain has led to the selection and heat-treatment of the steel wire so that a diameter of only 4 mils and a velocity of 24 in. a second can give high-quality reproduction with a signal-to-noise ratio of some 60 decibels. The material is a stainless steel, heat-treated with a current to bring it into the austenitic condition, and with a maximum ratio of the coercive force to remanence, this being the condition for minimizing the almost complete self-demagnetization of the disk-like magnets of which the wire seems to be comprised at the highest frequencies and shortest wave-lengths with tolerable loss.

Mr. Hobson gave an exposition of the theory of such longitudinal magnetization and explained the great advantage of polarizing the magnetizing current with a large component of high carrier-frequency current, which is also used for erasing. The standard machines use reels for recording for a total of 66 minutes, but sufficient quality is left at lower speeds for a total time of eight hours. The non-entertainment machine can run at various speeds for transmitting or receiving high-speed alternating-current signals, while the proposed music-machine not only uses a capstan on which ordinary disks can be played, but also includes an ingenious mechanism which automatically wraps the wire round the capstan for recording or reproducing from wire, thus making the machine substantially foolproof. If the wire should break, a knot can be tied in it.

Research in the South Pacific Area

An important outcome of the South Seas Conference at Canberra, January 28–February 6, 1947, attended by delegations representing the Governments of Australia, France, the Netherlands, New Zealand, Great Britain and the United States, which administer non-self-governing territories in the South Seas, was the signing of an agreement establishing the South Pacific Commission, which will seek to promote the economic and social welfare and advancement of two million people in the South Pacific. The Commission is to appoint an advisory research council of persons distinguished in fields of research within the competence of the Commission, including some full-time appointments of persons highly qualified in the fields of health and economic and social development, together with a full-time director of research. The functions of the research council include the maintenance of a continuous survey of research needs in the territories within the scope of the Commission, and making recommendations to the Commission on research to be undertaken; arranging for the prosecution of research studies approved by the Commission, using existing institutions where appropriate and feasible; and co-ordinating the research activities of other bodies working within the field of the Commission's activities, and availing itself, where possible, of the assistance of such bodies. The council may also appoint technical standing research committees

to consider problems in particular fields of research, and, with the approval of the Commission, *ad hoc* research committees to deal with special problems.

Grading of Scientific Films

A MEMORANDUM on "The Classification, Appraisal and Grading of Scientific Films" issued by the Scientific Film Association, 34 Soho Square, London, W.1, has been drawn up by the Association after consultation and discussion with interested bodies in Britain and in other countries. It is primarily concerned with films of scientific interest for adult audiences; but the method of appraising and grading recommended should be applicable to all types of documentary films. A specimen card on which it is recommended the content and lay-out of the data concerning each film should be standardized is appended, together with a definition of terms commonly used in a special sense by the film industry and film critics. Notes are included on the synopsis of the content of each film, which should be brief and objective, as well as on the determination of accuracy and comprehensiveness within the terms of reference laid down by the producer and with reference to the purpose of the film, while the grading of the film in relation to the types of audience likely to see it is considered separately. The organisation of the viewing panel, the appraisal group meetings, the appraisal standing committee and the records to be kept are dealt with in the next section, which includes a specimen viewers' report form. The Association hopes that the principles suggested here will be applied wherever films are appraised. It has earned the gratitude of scientific workers who may need to use such films, as a step towards a standard procedure for film documentation which, if accepted internationally, would be of immense value to all who make or use educational films.

Journal of Glaciology

THE Association for the Study of Snow and Ice, formed in 1936, has grown into the British Glaciological Society, which this year has started the publication of the *Journal of Glaciology*. There is room for such a publication not only to produce the papers read before the Society itself but also to consider many practical aspects of snow and ice. Without undue overlapping, it is clearly desirable to make contacts with various aspects of geomorphology, meteorology and geography. The *Journal* (price 7*s.* 6*d.*) is under an editorial committee consisting of Messrs. G. Seligman, W. L. S. Fleming, B. Roberts and R. Moss, and its present address is care of the Royal Geographical Society, London, S.W.7. The first number has varied contents following an introductory note by Prof. H. W. Ahlmann. Mr. G. Seligman explains Dr. R. Streiff-Becker's theory of extrusion flow in glaciers, and the Rev. W. L. S. Fleming discusses some of the Antarctic glaciological researches of Byrd's Third Antarctic Expedition. There are also a number of short articles and the first instalment of a list of recent glaciological publications, in the main non-polar works. The *Journal* promises to find a place among scientific periodicals of value.

U.S. Chemical Corps Advisory Committee

AT the request of Major-General Alden H. Waitt, chief of the U.S. Chemical Corps, an advisory committee has been appointed to serve as a liaison group between the Corps and the chemical profession and industry, and to provide advice on scientific and personnel matters in connexion with Chemical Corps research and development. The committee is as follows: Dr. W. Albert Noyes, jun., president of the American Chemical Society and head of the department of chemistry in the University of Rochester (*chairman*); Prof. R. Adams, University of Illinois; Prof. A. C. Cope, Massachusetts Institute of Technology; Colonel Bradley Dewey, of Cambridge, Mass., formerly U.S. Rubber Administrator; Dr. Willard H. Dow, president and chairman of the Dow Chemical Co., Midland, Mich.; Prof. Vincent du Vigneaud, Cornell University Medical College; Prof. Louis F. Fieser, Harvard University; Dr. Per K. Frolich, co-ordinator of research of Merck & Company, Rahway, N.J.; Prof. H. F. Johnstone, University of Illinois; Sidney D. Kirkpatrick, chairman of the American Section of the Society of Chemical Industry; Dr. Walter Kirner, director of the Chemical and Biological Coordination Center of the National Academy of Sciences; Dr. Stanford Moore, Rockefeller Institute for Medical Research; R. L. Murray, vice-president and technical director of the Hooker Electrochemical Co., Niagara Falls, N.Y.; Prof. Charles C. Price, Notre Dame University; Prof. Glenn T. Seaborg, University of California; Prof. Harold C. Weber, Massachusetts Institute of Technology; and Dr. Robert E. Wilson, chairman of the board of directors of the Standard Oil Co. of Indiana.

Chinese Fisheries

AFTER many years of devastation China is now, with the help of the United Nations, endeavouring to bring about the rehabilitation of her basic industries. Not least in importance is the fishing industry, and a Chinese Fisheries Research Institute has been formed for the purpose of carrying out investigations necessary to guide the Chinese fisheries industry during the difficult period of the immediate future and to provide data upon which to base enlightened fisheries administration. Implementation of this programme is severely hampered by lack of books and equipment, and an appeal has been launched for donations of any suitable books, journals and other periodicals that individuals or institutions may be able to spare. As the Institute possesses little more than a measuring-board in the way of equipment, donations of scientific apparatus will also be welcomed. All gifts and offers of help should be sent to the Director, Fisheries Research Institute, Room 402, National City Bank Building, 54 Kiukiang Road, Shanghai, China.

Quality Control Methods in Canada

A SPECIAL committee has just been established by the National Research Council of Canada to promote the application of mathematical methods in the treatment of certain industrial production problems. Members of the committee include specialists in statistical quality control procedures, in sampling surveys, in the design of experiments, and in biometry or the statistical study of variation; the chairman is Dr. J. W. Hopkins, National Research Council, Ottawa. The committee will assist Canadian users of mathematical statistical methods by consultation and advice respecting specific technical problems; it will also support research in this field by qualified workers, and provide a means of liaison with technical groups in Canada and abroad.

International Union of Biological Sciences : Fellowships

APPLICATIONS are invited for the following fellowships: two at the Zoological Station, Naples; one at the Marine Biological Station, Roscoff (France); one at the Central Bureau for the Cultivation of Fungi, Baarn (Netherlands). These fellowships are open to graduate students of biology in its widest sense from universities all over the world. The value of each fellowship will be 750 dollars for students from Europe, and 1,000 dollars for students from outside Europe (travelling and lodging expenses included); duration of stay at least eight months. Applications, giving full information concerning the proposed investigations, must reach the executive committee of the International Union of Biological Sciences, c/o Prof. M. J. Sirks, Genetisch Instituut, Huis de Wolf, Haren (Gron.), Netherlands, before October 1, 1947.

James Hutton Memorial

THE Royal Society of Edinburgh, in conjunction with the Royal Physical Society, the Edinburgh Geological Society, the Geological Society of Glasgow, and H.M. Geological Survey (Scotland), has appointed a committee to organise an appropriate commemoration of the 150th anniversary of the death of James Hutton, "the Father of Modern Geology". Among other items it is proposed to erect a granite panel, suitably inscribed, at the site of Hutton's unmarked grave in Greyfriars Churchyard, Edinburgh. Subscriptions are invited to defray the cost of this memorial. Any sum in excess of the amount required will be applied towards the cost of a publication, which is at present under consideration. Subscriptions, not to exceed 5*s*., should be sent to the Treasurer, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, for the James Hutton Memorial Fund.

The Night Sky in June

FULL moon occurs on June 3d. 19h. 27m., U.T., and new moon on June 18d. 21h. 26m. The following conjunctions with the moon take place: June 2d. 00h., Jupiter 0·02° N.; June 16d. 08h., Mars 0·7° N.; June 17d. 10h., Venus 1° S.; June 20d. 14h., Mercury 4° S.; June 21d. 11h., Saturn 4° S.; June 29d. 01h., Jupiter 0·3° S. Mercury is an evening star, setting at 21h. 43m. on June 1 and at 21h. 06m. on June 30. It attains its greatest eastern elongation on June 17 and is stationary on June 30. Venus is a morning star, rising at 3h., 2h. 44m., and 2h. 41m., at the beginning, middle and end of the month respectively. More than 90 per cent of the disk appears illuminated, and the stellar magnitude of the planet is −3·3. Mars rises in the early morning hours but is too close to the sun for favourable observation. Jupiter, in the constellation of Libra, can be seen until the early morning hours, setting at 3h. 06m. on June 1 and at 1h. 05m. on June 30. Saturn is visible in the early portion of the night, setting at 23h. 39m. and 21h. 54m. at the beginning and end of the month, respectively. Occultations of stars brighter than magnitude 6 are as follows: June 6d. 01h. 33·6m., ♀ Sgtr. (*D.*); June 6d. 02h. 50·8m., ♀ Sgtr. (*R.*). The latitude of Greenwich is assumed and *D.* and *R.* refer to disappearance and reappearance, respectively. A partial eclipse of the moon, partly visible at Greenwich, occurs on June 3. The moon enters the umbra at 18h. 56·2m. and leaves it at 19h. 34·2m. The eclipse will not be very spectacular, as its magnitude is only 0·024. Summer solstice occurs on June 22d. 06h.

Announcements

THE Very Rev. Alan Campbell Don, dean of Westminster, and Sir Robert Robinson, president of the Royal Society, have been elected honorary members of the Institution of Civil Engineers.

DR. J. H. QUASTEL, director of the Unit of Soil Metabolism of the Agricultural Research Council, has been appointed to the chair of biochemistry at McGill University, Montreal; he will be associate director of the newly created Institute for Special Research and Cell Metabolism and will also take charge of the Enzyme Division of the Institute. He is taking up his new duties on September 1.

WARNER MEMORIAL MEDALS for 1947 of the Textile Institute have been awarded to D. A. Derrett-Smith and Dr. D. A. Clibbens. These Medals were founded in 1930 in memory of the late Sir Frank Warner, formerly president of the Institute, and are given for original investigation published in the *Journal* of the Institute.

DR. HERMAN F. MARK, director of the Institute of Polymer Research and professor of organic chemistry at the Polytechnic Institute of Brooklyn, New York, has been invited to the Chair Francqui at the University of Liège for the academic year 1947–48. The Chair Francqui is a guest professorship involving the delivery of lectures at several Belgian universities for a period of about six months. Previous occupants of the chair have been P. Debye, H. S. Taylor, A. St. Györgyi and Victor Henry.

DR. E. EMMET REID, emeritus professor of chemistry in the Johns Hopkins University, research adviser to several colleges and universities in the southern United States, has been awarded the Herty Medal for outstanding contributions to chemistry in that region. The Herty Medal is given by the Chemistry Club of the Georgia State College for Women on the recommendation of the Georgia Section of the American Chemical Society. The late Dr. Charles H. Herty, after whom the medal is named, and who was president of the Synthetic Organic Chemical Manufacturers Association during 1921–26 and twice president of the American Chemical Society, was born on the site of the College campus.

MR. W. V. D. PIERIS, geneticist, left the service of the Coconut Research Scheme (Ceylon) in September, 1946. The designation of the post has been altered to botanist, and the board of management has appointed thereto Dr. T. S. Raghavan, formerly professor and head of the Department of Botany, Annamalai University, Annamalainagar, South India. Dr. Raghavan's interests have been mainly cytological and cytogenetical. Recently he has synthesized a new species of *Sesamum* by hybridization between *S. orientale* and *S. prostratum*. The sterile hybrid has been made fertile through the induction of amphidiploidy by artificial means. In the hybrid has been incorporated the perennial habit of the *prostratum* parent.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Quantum Theory of Liquids

A SHORT account of a general kinetic theory of liquids which we have recently published in *Nature*[1] ended with the enumeration of a series of problems yet unsolved which were our next aim. The most important of these generalizations is the quantum theory of liquids, because of the strange properties observed in liquid helium II.

An attempt to formulate such a theory has been made by Landau[2], in which he transcribed the hydrodynamical equations into operator equations. The meaning of these is obscure, and Landau makes no application of them apart from the general remark that in quantum liquids there will be 'phonons', which correspond to quantized acoustical waves, and 'rotons', which correspond to quantized vortex motion and will have a set of discrete states like those of the angular momentum in ordinary quantum mechanics. This idea is then used as the basis of some plausibility considerations by means of which he tries to explain some of the characteristic properties of He II. Landau's main result, the existence of two distinct velocities of sound, however, rests on quite different assumptions.

We cannot accept this assortment of unrelated suggestions as a solution of the problem of 'quantum liquids'. The correct approach consists, of course, in a direct application of the laws of quantum mechanics to a dense assembly of particles. There are no new principles involved (just as in our classical kinetic theory of liquids) but only mathematical difficulties to overcome, which are mainly due to the close packing. We found that the proper tool for this purpose is the 'density matrix', introduced by von Neumann[3] and Dirac[4] and studied in detail for equilibria by Husimi[5]. It is a function of two different configurations $X = (X_1, X_2, \ldots X_N)$ and $X' = (X'_1, X'_2, \ldots X'_N)$ of all N particles, $\rho_N(X, X')$, and it replaces the distribution function of co-ordinates X and velocities ξ, $f(X, \xi)$, which is used in classical theory. Its change in time depends on the differential equation

$$\mathfrak{h}\,\frac{\partial \rho}{\partial t} = W\rho - \rho W, \qquad (1)$$

where W is the energy operator and the products are matrix products according to the ordinary laws of quantum theory.

We proceed now, just as in the classical theory, by forming a set of distribution functions

$$\rho_1(X_1, X'_1), \rho_2(X_1, X_2, X'_1, X'_2), \ldots, \rho_N(X_1 \ldots X_N, X'_1 \ldots X'_N),$$

where each function is obtained from the following one by taking the trace with respect to one pair of variables. It can be shown that the function $\rho_q(X, X')$ satisfies an equation which differs from (1) only by adding a 'statistical term' quite analogous to that appearing in the classical theory. The diagonal terms of ρ_1 represent the number density $n_1(X_1)$, those of ρ_2 the radial distribution function $n_2(X_1, X_2)$, and it can be shown that just as in the classical theory all thermodynamic properties can be expressed in terms of these two functions.

The hydrodynamical equations (including the equation of continuity and that of energy transport) can then be derived in a straightforward way. Thus we obtain the main result, that the quantum laws governing the behaviour of matter in bulk are identical with the classical laws, in sharp contradiction to Landau's formalistic approach. Quantum theory appears only in the atomistic interpretation of the quantities appearing in the equations. It is in this interpretation where very great deviations from the ordinary behaviour of a 'classical' liquid are found. We enumerate a few of these below.

The dynamical equations contain a temperature T_1, defined by the mean kinetic energy, which is not identical with the equilibrium temperature T, defined as the integrating denominator of the entropy. It is the gradient of T_1 which determines the flux of energy. Hence it must be expected that heat transfer does not depend in the usual way on differences of temperatures T measured by thermometers. This makes the properties of He II at once appear less paradoxical.

In the same way, the pressure p_1, the gradient of which determines the acceleration of mass, is not identical with the thermodynamical pressure p, defined as the negative derivative of the free energy with respect to volume. Hence differences of ordinary pressure will not have the effect expected from the usual theory. Again, the application to He II is obvious.

Concerning the dynamical constants, the coefficients of viscosity and thermal conductivity, it can be shown that they are represented by exactly the same formulæ as in the classical theory. Each consists of two parts, a 'kinetic' one depending on the distortion of the velocity distribution by the flux, and a 'potential' one, depending on the distortion of the radial distribution function n_2. The first part alone appears in ideal gases, but is negligible in liquids. The anomalies in liquid helium are therefore presumably due to the properties of n_2, which for low temperatures are indeed quite different from those in the classical domain. This has been shown by detailed calculations made by one of us (H. S. G.) for the extreme case $T = 0$. At high temperatures the nearest approach of two particles is determined by repulsive forces; as the radial velocity vanishes at this distance, there is a considerable probability of finding particles just above this distance, and none a little below. Near the absolute zero, however, the velocities are small, hence the de Broglie wave-length is large compared with the range of the forces; no scattering takes place, but the velocity is increased by the attractive forces, which reach to greater distances than the repulsive forces. Hence the probability of finding particles at a given distance (which is reciprocal to the velocity) decreases from a larger distance, quite independently of the ordinary collision diameter. All physical properties expressed by integrals over functions which contain n_2 as a factor will therefore show anomalies at very low temperatures. For the case of viscosity these results are in agreement with an interpretation suggested by R. Fürth, which he explains below.

The main problem for a quantitative theory is the explanation of the thermodynamical discontinuity separating normal He I from abnormal He II. For this purpose the temperature-dependence of n_2 has to be studied; investigations of this question are in progress (H. S. G.). This function n_2 is also obtainable by experiments with X-rays. The measurements published by Keesom and Taconis[6] and by Reekie[7], however, are much too inaccurate to allow a direct

comparison with theory. We wish to direct the attention of the experimentalists to this important problem.

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March 17.

[1] Born, M., and Green, H. S., *Nature*, **159**, 251 (1947).
[2] Landau, L., *J. Phys.*, **5**, 71 (1941).
[3] v. Neumann, J., "Math. Grundl. d. Quantenmechanik" (Springer, Berlin, 1932), chapter 4.
[4] Dirac, P. A. M., "The Principles of Quantum Mechanics" (Oxford Univ. Press, 1935), § 37.
[5] Husimi, K., *Proc. Phys.-Math. Soc. Japan*, iii, **22**, 264 (1946).
[6] Keesom, W. H., and Taconis, K. W., *Physica*, **5**, 270 (1939).
[7] Reekie, J., *Proc. Camb. Phil. Soc.*, **36**, 236 (1940).

IT occurred to me some time ago that the phenomenon of superfluidity might be qualitatively understood on the basis of the concept of de Broglie waves in analogy to the Ramsauer effect. At sufficiently low temperatures and consequently very small thermal velocities, the de Broglie wave-lengths of the atoms ought to become large compared with the atomic dimensions; thus the collision cross-sections of the atoms must become very small, and hence all those phenomena which are due to atomic collisions should become insignificant. Consequently, if a substance can exist in the 'liquid state' at all at such a low temperature, it will have a vanishingly small viscosity. I have pointed out this idea in discussions and lectures on the subject in the past, but did not think fit to publish it without a proper quantum-mechanical treatment. It is very satisfactory that this has now been done by Born and Green quite independently, and that the result of their theory essentially confirms the qualitative picture outlined above.

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Infra-Red and Raman Spectrum of *Cyclo*-octatetraene

As part of work on the structure and properties of *cyclo*-octatetraene, we have recently measured the infra-red spectrum between 2 μ and 20 μ of the liquid and vapour and the Raman spectrum of the liquid. The sample was prepared specially for this purpose, and purified by repeated re-crystallization. The infra-red spectra were measured with single- and double-beam recording spectrometers using prisms of rock salt, fluorite and potassium bromide. The Raman spectrum was excited with the mercury line 5461 A., which lies to the long wave-length side of the onset of absorption, and photographed with a spectrograph having a large glass prism giving high resolution and medium dispersion.

The following Raman displacements were found (cm.$^{-1}$): 193(9), 294(4), 372(7), ? 488(0), 874(8), 950(5), 1205(5), 1440(2), 1655(10), 1740(1), 2950(5), 3003(10).

The infra-red bands found with the liquid were as follows (cm.$^{-1}$): 675(v.s.), 762(w.), 802(v.s.), 849(v.w.), 875(v.w.), 890(v.w.), 913(v.w.), 944(s.), 968(m.), 993(w.), 1033(w.), 1098(v.w.), 1140(v.w.), 1208(m.), 1228(m.), 1405(m.), 1580(m.), 1642(s.), 1734(m.), 1754(m.), 1789(w.), 1879(w.), 1922(w.), 2008(v.w.), 2340(v.w.), 2749(v.w.), 2789(v.w.), 2834(w.), 2970(m.), 3009(v.s.), 3281(v.w.).

With the vapour, at temperatures up to about 80° C., some of the bands showed a well-defined contour. Thus the intense liquid bands at 802 and 675 cm.$^{-1}$ each split into a three-branch type at 793, 802, 813 cm.$^{-1}$ and 659, 670 and 681 cm.$^{-1}$. The liquid bands at 944 and 968 cm.$^{-1}$ also showed contour which seems to be of the same type; but the branches overlap and the exact position of the sub-maxima observed may not be directly useful. Each of the bands at 1208, 1228 cm.$^{-1}$ found with the liquid appears to show contour, but overlapping again obscures it. Near 3 μ, bands were found with the vapour at 2745(v.w.), 2834(w.), 2970(m.) and 3019(v.s.).

It is hoped to carry out a normal co-ordinate treatment of the results, and a complete discussion is therefore postponed; but the following comments may be made. First, while the Raman intervals obtained agree well with those recently reported by Lippincott and Lord, we have been unable to observe many of the weak displacements listed by these authors. It is peculiar that we failed to observe their fairly strong Raman interval of 249 cm.$^{-1}$; but as regards the remaining weak lines given by them it is possible that our exciting radiation was not intense enough to make them noticeable, in spite of repeated trials. On the other hand, it is possible that some of the weaker lines reported by them were due to residual impurities, but against this it is noteworthy that at least some of the intervals correspond to infra-red bands observed by us.

It is quite certain that a number of 'coincidences' between the Raman and infra-red spectra of the liquid occur. Unless the selection rules break down with the liquid, this would preclude the presence of a centre of symmetry. Other factors likely to indicate the exact selection rules which operate are less obvious. We have considered the results in terms of the structures D_{2d}, D_{8h}, D_{4h}, D_4 and D_{4d}, and while no clear decision seems possible, are inclined to think that they are in best agreement with the non-planar cradle type D_{2d} structure.

The solid polymer formed from *cyclo*-octatetraene on standing has also been examined in the infra-red. The presence of strong bands near 10 μ and 3 μ suggests that it contains hydroxyl groups.

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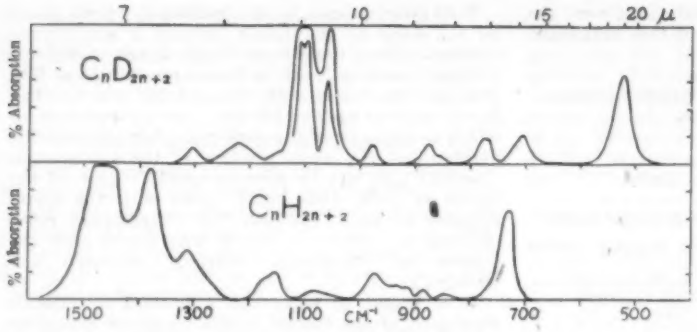
Infra-Red Spectrum of C_nD_{2n+2} and the 'Long-Chain Frequency' in Paraffins

THE most characteristic feature in the infra-red spectrum of any long-chain paraffin (C_nH_{2n+2}) is a strong band near 14 μ (725 cm.$^{-1}$). It was first noted by Coblentz[1], but Lecomte[2] and many other workers have directed attention to it, while an extensive investigation of hydrocarbons at Oxford and Cambridge[3] during the War showed that any molecule containing the group $-(CH_2)_n.CH_3$, in which n is equal to or greater than 3, possesses this band. So far as we are aware, no satisfactory interpretation of



this 'long-chain frequency' has yet been given[4], although it has been frequently assumed that it arises from a 'skeletal' vibration of the carbon atoms in the chain. The difficulty about this assignment is that the magnitude of the frequency is rather low for it to belong to a stretching mode of the carbon chain, and distinctly too high for it to be a deformation vibration. Recently, it has been suggested[5] that it is due to the overtone of a deformation vibration.

We have just investigated the infra-red spectrum of a fully deuterated long-chain paraffin and found, as expected, that all the bands well known to be due to vibrations of the hydrogen atoms (for example, those at 6·9 and 7·3 μ) were shifted to longer wave-lengths by approximately $\sqrt{2}$. However, we found that the band near 14 μ (725 cm.$^{-1}$) had also shifted and now appeared near 19 μ (522 cm.$^{-1}$), which corresponds almost exactly to lowering by $\sqrt{2}$. This proves conclusively that the 14 μ band in long-chain paraffins is not a skeletal frequency of the carbon chain but a vibration associated almost entirely with the hydrogen atoms. It seems most probable that it arises from a rocking vibration of the pairs of hydrogen atoms in the methylene (CH_2) groups, but a full discussion of the evidence for this interpretation will be published elsewhere.

We are much indebted to Mr. N. H. E. Ahlers for help in making some of the observations.

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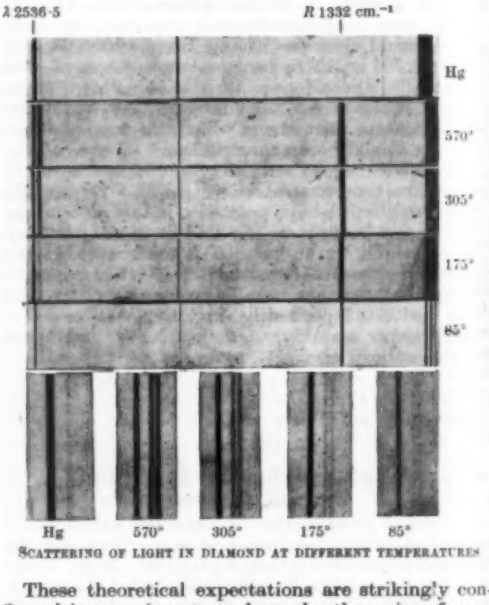
March 29.

[1] Coblentz, W. W., *Astrophys. J.*, **20**, 207 (1903); *Phys. Rev.*, **16**, 385 (1903).
[2] Lecomte, J., "Le Spectre Infrarouge" (Paris, 1928), also Lambert.
[3] Sutherland, G. B. B. M., and Thompson, H. W., to be published shortly.
[4] For example, Whitcomb, S. E., Nielsen, H. H., and Thomas, L. H., *J. Chem. Phys.*, **8**, 143 (1940).
[5] Ahonen, C. O., *J. Chem. Phys.*, **14**, 614 (1946).

Thermal Scattering of Light in Diamond

Recent determinations by Bhagavantam and Bhimasenachar[1] of the velocity of sound in diamond show it to be large, about 18,000 metres per sec. for longitudinal waves and about 9,600 metres per sec. for transverse waves along the (111) direction. A simple calculation using these values and the known refractive index of diamond ($\mu = 2{\cdot}61$) shows that the resulting Doppler displacements in the frequency of monochromatic light scattered transversely in diamond should be large enough to be recorded directly without interferometric aid using a quartz spectrograph of moderate power; the separation of the two components shifted in opposite directions would be 16 cm.$^{-1}$ for longitudinal waves and 8 cm.$^{-1}$ for transverse waves. These values refer to the case in which the λ 2536·5 radiation of the mercury arc in quartz is the incident radiation. A special advantage in using this radiation is that parasitic illumination of unaltered wave-length can be quenched by the use of a mercury vapour filter placed in front of the slit of the spectrograph, thereby enabling the Doppler-shifted components in the scattered light from within the crystal to be recorded without any intervening line of unaltered wave-length.



Scattering of Light in Diamond at Different Temperatures

These theoretical expectations are strikingly confirmed in experiment, as shown by the series of spectrograms reproduced herewith; the first of the series represents the incident radiation after quenching by a mercury vapour filter, and the following four are spectrograms of the transversely scattered light with the diamond held at various temperatures. These spectrograms were taken with a Hilger medium quartz spectrograph; the diamond was of the ultra-violet transparent type (No. 174 in Sir C. V. Raman's personal collection). The doubling of the 2536 line in the spectrograms is clearly seen, while in the lower reproduction the same effect is shown on an enlarged scale. It will be noticed from the upper reproduction that in contrast with the strong Raman line having a shift of 1332 cm.$^{-1}$, the intensity of which is practically unaffected by the change of temperature of the diamond, the Doppler-shifted lines become rapidly weaker with falling temperature. This is to be expected on theoretical grounds, since for them $h\nu_1 \ll kT$, while for the Raman line $h\nu_r \gg kT$.

I have determined theoretically, with the aid of the recent determinations by Ramachandran[2] of the

elasto-optical constants of diamond, the absolute intensity of scattering by the sound waves of thermal origin in diamond. It comes out to be of the same order of magnitude as that actually observed in these experiments, though an exact quantitative test of the theoretical formulæ is as yet lacking. It will be noticed that at all the temperatures actually employed, the Doppler-shifted components are much less intense than the Raman line arising from the principal lattice vibration.

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March 12.

[1] Bhagavantam, S., and Bhimasenachar, J., *Proc. Roy. Soc.*, A, **187**, 381 (1946).
[2] Ramachandran, G. N., *Proc. Ind. Acad. Sci.*, A, **25**, 208 (1947).

X-Ray Spectra of Trans-Uranic Elements

In view of the recent discovery of elements with atomic numbers 93–96, it is of interest to recall a calculation based on the assumption of a minimum proper length for the world-line of an electron[1]. The conception that it is impossible to discriminate in space-time between two positions of the electron when the interval separating them is less than h/m_0c (m_0 = rest mass) leads to the result that an electron in a Bohr orbit cannot have a velocity greater than $c/\sqrt{2}$. A further consequence of this is that a K-ring cannot exist in an atom for which $Z > hc/2\sqrt{2}\pi e^2$; and this means that the Bohr–Rutherford model would stop at $Z = 96$. Although the original argument leading to this result cannot be regarded as free from objection in the light of modern quantum theory, the likelihood of some such limitation remains. A more recent application of the principle of minimum length and time to the Rutherford–Bohr atom sets the upper limit to Z somewhat lower than 96[2].

According to a theory of the structure of the nucleus[3], a limit to Z occurs in the form $Z^2/A < 47{\cdot}8$, a result which suggests that this limit may actually be set by $Z^2/A < hc/4\sqrt{2}\pi e^2 = 48{\cdot}44$. From this, at any rate, it appears likely that nuclei occur with Z values higher than 96, and from what is known of the artificial production of trans-uranic elements it may be anticipated that such nuclei will be produced. Their life, however, may be short owing to the probability of spontaneous fission increasing rapidly with Z^2/A [4].

In view of what has been said above regarding possible anomalies in the K-rings of such atoms, it will be of interest to examine, if possible, the K and L radiations in their X-ray spectra in order to ascertain if the Moseley sequence of X-ray spectral lines shows a break at an element close to 96.

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March 6.

[1] Fisher, J. W., and Flint, H. T., *Proc. Roy. Soc.*, A, **115**, 210 (1927). Flint, H. T., and Richardson, O. W., *Proc. Roy. Soc.*, A, **117**, 637 (1928). Flint, H. T., *Proc. Roy. Soc.*, A, **117**, 630 (1928).
[2] Glaser, W., and Sitte, K., *Z. Phys.*, **87**, 674 (1934).
[3] Bohr, N., and Wheeler, J. A., *Phys. Rev.*, **56**, 426 (1939).
[4] *Nature*, **159**, 243 (1947).

A New Criterion of Yielding in Metals

Several theoretical criteria of yielding have been proposed[1,2] and tested by comparing the stress values found experimentally just as yielding began under simple stress systems. For example, the ratio of simple shear yield stress to simple tensile yield stress T_0/S_0 is given variously by older theories as 1, 0·77, 0·50, 0·62, while experimentally for common engineering materials this ratio is found to be 0·56 approximately. A better fit to experiment is the theory credited jointly to Huber, von Mises and Hencky (ref. 1, p. 478), which for the above ratio gives $1/\sqrt{3}=0{\cdot}577$. This theory stated in Hencky's form for the stress system S_{ii}, etc., when $i = 1, 2, 3$, $j = 2, 3, 1$, is

$$\Sigma[(S_{ii} - S_{jj})^2 + 6\,S_{ij}^2] = 2\,S_0^2$$

just as yielding is beginning. If the system of stresses is two-dimensional simple shear together with simple tension, then the Huber criterion gives an ellipse by plotting shear stress as ordinate and simple tension as abscissa. Experimental examination[3,4] shows the experimental values to lie approximately on the theoretical ellipse.

The Huber expression is not convenient analytically because it is not linear in the stresses. I noted this in my theory of post-yield stress-strain[5], but have only recently looked for another criterion that would have a linear form in the stresses. The form that follows came from reasoning that was stimulated by a new theory of large strains[6]. However, in this present communication I will merely show arbitrarily that a linear expression can fit the experimental evidence already quoted.

It is found that $T_0/S_0 = 1/[\sqrt{2}(1+q)\,] = 0{\cdot}56$ when Poisson's ratio, q, is 0·26, and departs slightly from this value as q varies from metal to metal. This value coincides with the experimental value quoted for common engineering metals.

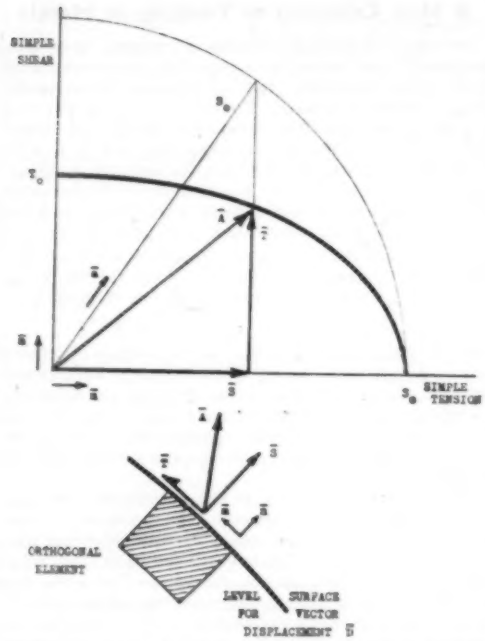
Now consider the ellipse of stress. For any general point stated in terms of the radial vector **a** and the vector stresses **S**, **T**,

$$(\mathbf{T} + \mathbf{S}) = \mathbf{a} \cdot \left[\frac{\mathbf{mm}}{\sqrt{2}(1+q)} + \mathbf{nn}\right] S_0,$$

where the dot indicates the scalar product of the unit vectors **a**, **m**, **n**. This defines the ellipse and reduces to the correct values for S_0, T_0, and hence satisfies the experimental values due to Taylor. Note that in Taylor's tests under simple tension and torsion the level surfaces of vector displacement[3] were planes normal to the longitudinal axis (that is, normal to **n** of the thin tubes used). However, in the general strained body, curved level surfaces of vector displacement are defined. In the simple experimental system or in the more general complex stress systems, the vector $\mathbf{A} = (\mathbf{S} + \mathbf{T})$ is the resultant stress on the face of an orthogonal element with that face in the level surface of vector displacement. In general, the element can be oriented so that **T** has no component normal to the plane of **m** and **n**.

Note that the discussion has been for the simple tensile yield stress S_0, using the first and fourth quadrants of the diagram. Equally well S_0 could be the compression yield, and then one would use the second and third quadrants of the diagram. This may be necessary, for example, with metals having a lower yield stress under compression than they have under tension.

The above linear expression in **S**, **T**, S_0 is suggested as a new criterion of yielding in the general complex



stress case. Such a linear form will allow easier analysis of many particular cases arising from the application of my theory of post-yield stress-strain[5]. In that theory the Huber criterion was used to give the simple tensile stress 'corresponding' to the complex stresses operating at any point in the yielded field. The new linear criterion can be used in the same way.

It is suggested tentatively that the criterion may apply to rupture, in which case S_0 is the simple tensile rupture stress for the metal. Examination of this hypothesis will require the analysis of stresses due to the usually large rupture deformations in some simple cases, and then comparison with the experimental values of the corresponding loads.

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March 8.

[1] Timoshenko, S. P., "Strength of Materials", **2**, 473–481 (Macmillan, 1941). Note eqn. 314 should read 0·577 and not 0·557.
[2] Nadai, A., "Plasticity", 59–69 (McGraw-Hill, 1931).
[3] Taylor, G. I., *Phil. Trans. Roy. Soc.*, A, 323 (1932).
[4] Lode, W., *Forschungsarbeiten a. d. Gebiete d. Ingenieurwesens*, No. 303 (VDI-Verlag, Berlin, 1928).
[5] Swainger, K. H., *Phil. Mag.*, vii, **36**, 443 (1945).
[6] Swainger, K. H., awaiting publication.

Hiedemann Patterns at Very High Frequencies

DIFFRACTION patterns in liquids have recently been produced in this laboratory by using ultra-sonic waves of frequencies above 100 Mc./sec., and certain interesting features of such patterns have been studied[1]. With a 2-mm. tourmaline plate, frequencies up to 103 Mc./sec. are now communicated to a glass slab as sound waves and the corresponding diffraction patterns obtained by allowing light to pass through the glass slab, as was first done by Hiedemann[2], but at much lower frequencies. The thickness of the glass slab used in our investigations is such that at these frequencies it oscillates at about its 300th harmonic.

Patterns due both to longitudinal and torsional sound waves are obtained either individually or simultaneously. It has been found that by attaching a suitable oscillator plate such as a Y-cut quartz to the glass slab, the longitudinal wave may be suppressed and the torsional wave made prominent and so on. The polarization characters of such diffraction patterns already reported by Hiedemann and others have all been verified. In an earlier communication referred to above, we have reported that the sound wave in water at such high frequencies causes diffraction, which appears to be very much like reflexion in the Bragg sense. In these investigations, also, we have tried the effect of tilting the sound wave-front with reference to the incident light, and found that it introduces a marked asymmetry enhancing the intensity of the diffraction order on the appropriate side, but does not cause it to such an extent as altogether to extinguish the order on the opposite side at small inclinations, as has been found in water. This result is to be expected if we remember that the velocity of sound in glass is nearly four times as great as that in water, making the grating element at such high frequencies in the former four times as large as that in the latter. Consequently, effects due to tilting the sound wave-front obtained in glass at 100 Mc/sec. should be like those obtained in water at 25 Mc./sec. only, which is indeed the case.

The velocities obtained for longitudinal waves of four different frequencies and a torsional wave (46·46 Mc./sec.) in the glass slab are given below:

Frequency, in mc./sec.	13·24	20·74	47·04	103·55	46·46 (T)
Velocity, in km./sec.	6·01	6·02	6·02	6·04	3·68

Elastic moduli calculated from the above data are $Y = 8{\cdot}03 \times 10^{11}$ dynes per sq. cm., $n = 3{\cdot}34 \times 10^{11}$ dynes per sq. cm., and $\sigma = 0{\cdot}201$.

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[1] [*Nature*, **159**, 267 (1947).]
[2] *Naturwiss.*, **23**, 705 (1935).

Heat of Atomization of Carbon

IN connexion with the series of communications under the above title[1], I wish to direct attention to an old paper which contains an accurate computation of the metastable ^5S state of the carbon atom[2]. The value given in that paper is 4·3 eV. above the ground-state of carbon, and the uncertainty is less than 0·1 eV. This is equivalent to 100 ± 2 kcal./mole.

The method of computation used in that paper is based on quantum mechanical perturbation theory. It differs radically from the usual iso-electronic extrapolation method, because it uses relations between energy states belonging to the same atom and its ions instead of comparing neighbouring atoms. The method gives surprisingly accurate predictions, especially for low levels of high multiplicity. For example, for the similar sp^3 ^5S levels in N II and O III, the computation yields 135 and 173 kcal./mole, whereas the observed values are 133 and 171 kcal./mole.

A comparison with these two examples and with many other cases gives an indication of the size and direction of the error in the computation. The most probable value for the ^5S state of carbon is close to 98 kcal./mole, in good agreement with Edlén's estimate of 94 ± 2 kcal./mole.

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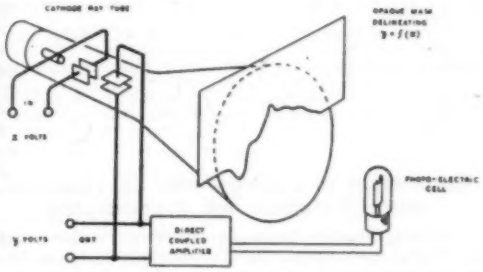
March 10.

[1] *Nature*, **159**, 129 (1947).
[2] Bacher, R. F., and Goudsmit, S., *Phys. Rev.*, **46**, 948 (1934), see p. 962.

Electronic Function Generator

IT is interesting to compare the accompanying diagram with that given by Mr. D. M. MacKay in a recent communication[1]. The present diagram is from the original sketch used in a paper I read to the Rugby Engineering Society on February 6, 1946[2]. This particular embodiment of the idea was demonstrated on the same occasion.



In addition to the applications mentioned by Mr. MacKay, it is possible to combine a pair of electronic function generators to form a high-speed electronic analogue multiplying unit. This aspect has been dealt with in an article which was accepted for publication[3] towards the end of 1946.

A provisional patent application was filed by me and the British Thomson-Houston Co., Ltd., early in 1946[4], and pre-dates the application quoted by Mr. MacKay by some ten months. A complete specification was filed on January 14 this year.

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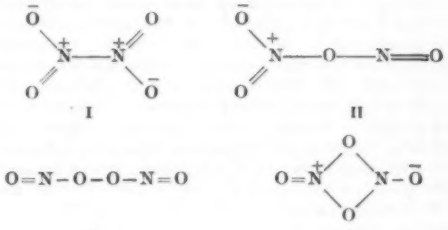
[1] *Nature*, **159**, 406 (1947).
[2] "Elementary Calculations by Electrical Means".
[3] *Electronic Engineering*, in the press.
[4] Brit. Prov. Pat. Spec. No. 3285/46.

Constitutions of Dinitrogen Tetroxide and Trioxide

THE structure of dinitrogen tetroxide has recently been much discussed, but no clear conclusion has been reached. The structure of dinitrogen trioxide has less often been explicitly considered, but it, too, has remained uncertain.

In general terms, the position with regard to dinitrogen tetroxide has been that, while physical evidence has pointed to structure I, chemical evidence has been held to require some structure, such as II, which is capable of dividing, in addition reactions, to produce a nitroso-group *inter alia*. Structure III has been suggested, but not seriously supported. One proposal for satisfying both the physical and chemical requirements has been to assume forms such as I, II and III in equilibrium[1]. Structure IV represents a very special concept which has been introduced[2] in another attempt to reconcile the physical and chemical indications. (For simplicity, mesomeric states will be represented in each case by a principal valency structure.)

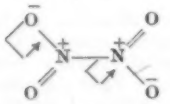


The main point of the chemical evidence has been that, according to the older organic chemical literature, a variety of groups, including nitroso-, nitro-, nitrito- and nitrato-groups, have been introduced into organic compounds by the action of dinitrogen tetroxide[3]. However, this evidence is largely annulled by the recent work of Levy and Scaife[4], from which it is clear that the complicated picture presented by the older literature is the result of an insufficiently exact control of experimental conditions. These authors show that there are but two primary products of the addition of dinitrogen tetroxide to simple olefins, namely, dinitro-compounds and nitro-nitrito-compounds, and that, in the latter products, the nitro-group attaches itself to that carbon atom which carries the larger number of hydrogen atoms. They conclude that, so far as their results are concerned, there is little to choose between formulæ I and II; but we are going to suggest that, considered in a somewhat wider setting, their work completes a chain of evidence leading to a more specific inference.

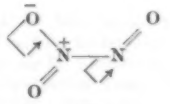
As regards physical evidence on the structure of dinitrogen tetroxide, some firm conclusions can be drawn from the spectroscopic work of Sutherland[5]. This shows that the molecule possesses a centre of symmetry, and that it has a low, very intense, Raman frequency, such as would arise from a weak central bond. It also excludes the presence, in any large amount, of any tautomer not fulfilling these conditions. This indicates formula I, though it does not clearly exclude either III or IV. (Mesomerism confers an NN-link on IV.) Formula I is also supported by Giauque and Kemp's measurements of the entropy of dinitrogen tetroxide[6]; and Hendricks has shown[7] that the same structure provides a consistent interpretation of Végard's X-ray data[8].

The additive reactivity of dinitrogen tetroxide shows that it is an electrophilic addendum, and adds in the successive parts nitronium ion and nitrite ion. The nitronium ion goes where a proton would in an addition of hydrogen chloride, and it necessarily forms a nitro-group, while the nitrite ion can attach itself to the remaining position either as a nitro- or as a nitrito-group. Either formula I or II can fulfil these conditions, and using formula I the necessary polarization is illustrated in V. We need not consider the question of the free life, if any, of the anionic component of the addendum, since this must depend on

the precise conditions of each reaction. Levy and Scaife have found that dinitrogen trioxide adds to simple olefines to form nitro-nitroso-adducts, in which the nitro-group again attaches itself to the carbon atom carrying the greater number of hydrogen atoms. This shows that the trioxide is also an electrophilic addendum, and that it adds in the successive parts nitronium ion and 'monomeric hyponitrite' ion. The structure of dinitrogen trioxide, and its polarization in additions, are therefore as shown in formula VI; and the direction of polarization need cause no surprise, since LeFèvre[9] has pointed out that the tautomeric electron-attraction of the nitroso-group is greater than that of the nitro-group. Formula VI clearly accords with the blue colour of the trioxide, and, since N—N links in general are weak, with its ready dissociability. Finally, taking account of the auto-oxidation of dinitrogen trioxide to dinitrogen tetroxide at − 100°, and of the reduction of the latter by nitric oxide back to the trioxide at − 150°[10], one may conclude that dinitrogen tetroxide is correctly represented by formula V (= I).



V



VI

Thus, having regard to both the physical and chemical evidence, we feel that the long-debated question of the structures of the stable forms of these oxides may be regarded as settled.

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March 28.

[1] Schaarschmidt, *Z. angew. Chem.*, **31**, 933 (1924).
[2] Longuet-Higgins, *Nature*, **153**, 408 (1944).
[3] Riebsomer, *Chem. Rev.*, **36**, 157 (1945).
[4] *J. Chem. Soc.*, 1093 *et seq.* (1946).
[5] *Proc. Roy. Soc.*, A, **141**, 342 (1933).
[6] *J. Chem. Phys.*, **6**, 40 (1938).
[7] *Z. Phys.*, **70**, 699 (1931).
[8] *Z. Phys.*, **68**, 184 (1931).
[9] *Nature*, **130**, 400 (1932).
[10] Francesconi and Sciacci, *Gaz. Chim. ital.*, **34**, I, 447 (1904).

Retinene$_2$ and Vitamin A$_2$

Retinene$_1$, first noted by Wald in his work on the visual-purple cycle, is the aldehyde of vitamin A[1], from which it has been prepared in high purity[2]. Retinene$_2$, the corresponding aldehyde of vitamin A$_2$, enters into the porphyropsin cycle of freshwater fish retinas. It has been obtained by fractionation of the aldehydes prepared from a mixture of vitamins A$_1$ and A$_2$ derived from ling-cod liver oil[3]. As described by Wald, retinene$_2$ shows $\lambda_{max.}$ 405 mμ in chloroform and 705 mμ in the antimony trichloride colour test. The preparation obtained by oxidation of vitamin A$_2$ by means of manganese dioxide shows $\lambda_{max.}$ 405 mμ (chloroform), 385 mμ (cyclohexane), and 720 mμ (antimony trichloride test) fading to 705 mμ.

If vitamin A is oxidized by means of aluminium tertiary butoxide (Oppenauer reaction) using benzene as solvent and diethyl ketone as hydrogen acceptor, a C_{20} aldehyde is obtained[4,5]. This aldehyde cannot be distinguished from retinene$_2$. When fed to vitamin A-deficient rats, it gives rise in the lining of the small intestine and in the liver to a product showing the properties of vitamin A$_2$ ($\lambda\lambda_{max.}$ 345 mμ, 284 mμ; 693 mμ, antimony trichloride colour test). When retinene$_1$ is similarly treated with aluminium tertiary butoxide, the C_{20} aldehyde is obtained in better yield.

Retinene$_2$, prepared from ling-cod liver oil (that is, from vitamin A$_2$) by oxidation with manganese dioxide, gives a crystalline 2,4-dinitrophenylhydrazone, m.p. 160–161°. The C_{20} aldehyde prepared from vitamin A or retinene$_1$ gives the same compound (no depression in mixed melting point).

These experiments indicate that vitamin A$_2$ differs from vitamin A by one additional conjugated double bond situated in the ring. This agrees with the structure attributed to the C_{20} aldehyde by Heilbron and his colleagues[4]. The aldehyde[6] corresponding in structure with Karrer's alternative formulation for vitamin A$_2$ is very different from retinene$_2$.

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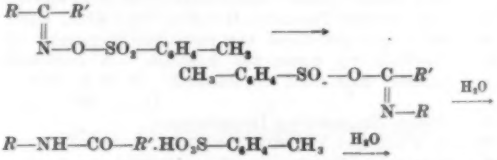
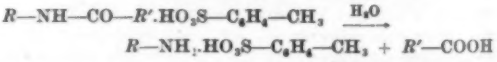
April 1.

[1] Morton, R. A., and Goodwin, T. W., *Nature*, **153**, 405 (1944).
[2] Ball, S., Goodwin, T. W., and Morton, R. A., *Biochem. J.*, **40**, *Proc.* lix (1946).
[3] Morton, R. A., Salah, M. K., and Stubbs, A. L., *Biochem. J.*, **40**, *Proc.* lix (1946).
[4] Howarth, E., Heilbron, I. M., Jones, W. E., Morrison, A. L., and Polya, J. B., *J. Chem. Soc.*, **126** (1939).
[5] Hawkins, E. G. E., and Hunter, R. F., *Biochem. J.*, **38**, 34 (1944).
[6] Karrer, P., Geiger, A., and Bretscher, E., *Helv. Chim. Acta*, **24**, 161E (1941).

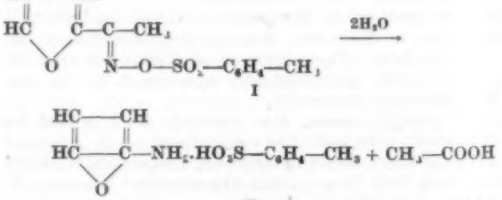
Conversion of 2-Aceto-furan to Hexen-2-dion-4,5-acetal-1 and Pyrocatechol

Several workers have already tried unsuccessfully to synthesize 2-amino-furan[1], probably because this compound decomposes very readily. Nevertheless, it was thought that the substance might be produced by a milder procedure. Therefore, we have tried to apply to furan derivatives the reaction discovered by P. W. Neber[2] on *p*-toluenesulphonyl derivatives of certain aromatic ketoximes, according to the following scheme.





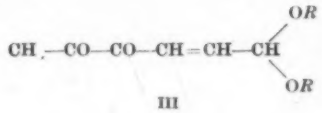
However, on shaking *p*-toluenesulphonyl 2-aceto-furan-oxime (I) with ethanol, not the expected 2-amino-furan or rather its toluenesulphonic acidic salt (II) was formed; but, in addition to toluenesulphonic acidic ammonium, a yellowish-green, strongly



I

II

reducing liquid, free of nitrogen, very sensitive to heat, which can be distilled *in vacuo* at constant temperature, without being decomposed. The analysis and determination of the molecular weight gave the elementary formula $C_{10}H_{14}O_4$ (III). Methanol, instead of ethanol, gives rise to a very similar, though different, substance with the formula $CH_{12}O_4$ (IV), showing the same properties as (III). The constitution and configuration of these interesting substances were determined by various methods, and they can be represented by the structural formulæ III and IV:



III

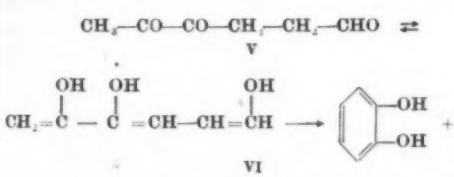
$R = -C_2H_5$. $R = -CH_3$

IV

III and IV are, therefore, to be designated as *cis*-hexen-2-dion-4,5-diethylacetal-1, and dimethylacetal-1, respectively.

In the course of our further work, we endeavoured to study the free aldehydes, corresponding with the acetals III and IV. However, the unsaturated diketo-aldehyde (*cis*-hexen-2-dion-4,5-al-1, CH_3—CO—CO—CH=CH—CHO) could not be produced by hydrolysis of III or IV, because the carbon chain between the carbonyl groups 4 and 5 splits up with formation of acetic acid, even in cold aqueous solution.

The hydrolysis of the saturated acetals (obtained by catalytic hydrogenation of III and IV) also leads to a surprising result; because instead of the expected diketo-aldehyde (hexen-dion-4,5-al-1, V) there was produced pyrocatechol, the formation of which, however, can easily be explained through the enol form VI:



V

VI

Since pyrocatechol and its derivatives are very common in Nature, it is perhaps of interest to show a possible way by which they can eventually be formed from carbohydrates through furan derivatives.

At present no definitive explanation can be given of the mechanism of the conversion of I to III and IV. It is very probable that the reaction does not go according to Neber's formulæ through 2-amino-furan, for by this means the formation of a six-membered carbon chain cannot be explained.

A more detailed description of these investigations will be published elsewhere.

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[1] Leimbach, R., *J. Prac. Chem.*, (ii), **65**, 20 (1902). Singleton, H. M., and Edwards, W. R., *J. Amer. Chem. Soc.*, **60**, 540 (1938).
[2] Neber, W. P., *Ann.*, 449, 109 (1926). Neber, W. P., and Huh, G., *Ann.*, 515, 292 (1935).

Kinetics of Polymerization and Molecular Weight Distributions in Polymethyl Methacrylates

Recently, Evans and co-workers[1,2] have examined the polymerization of methyl methacrylate in aqueous solution, when the initiation of polymerization was by hydrogen peroxide in the presence of ferrous ions. The suggested reaction scheme was as follows:

$$\begin{aligned} H_2O_2 + Fe^{++} &\rightarrow Fe^{+++} + OH + OH^- \\ M + OH &\rightarrow A_1 \\ A_1 + M &\rightarrow A_2 \\ A_{r-1} + M &\rightarrow A_r \\ A_r + A_s &\rightarrow P_{r+s} \end{aligned}$$

Algebraic expressions were derived giving the rate of disappearance of monomer and also the distribution of molecular weights in terms of concentrations and the rate constants of individual reaction steps.

Equations appropriate to this reaction scheme arise as special cases of the more general treatment previously given by us[3]. While the kinetic expressions which result from the general treatment are identical with those presented by Evans *et al.*[1,2], the molecular weight distribution function is obtained in a different form. In this note it is suggested that the equations for molecular weight distribution derived from the more general treatment[3] possess certain advantages over those proposed by Evans.

Adopting the same symbols as in the papers by Evans, and substituting in the appropriate distribution function for termination by combination which is given at the bottom of page 497 of ref. 3, there results the following equation:

$$P_r = \frac{a_0^3\beta^3}{2M_0^2}\, r \int_{M/M_0}^{1} \gamma^{3\beta-1} \exp\left(\frac{-a_0\beta}{M_0}\,\gamma^{\beta-1}\, r\right) d\gamma \quad (1)$$

Equation (1) should be compared with the equation (17) presented by Evans *et al.*, which may be written as

$$P_r = \frac{a_0^3\beta^3}{2M_0^3}\,(r-2) \int_{M/M_0}^{1} \gamma^{3(\beta-1)} \left[1 + \frac{a_0\beta}{M_0}\,\gamma^{\beta-1}\right]^{-r} d\gamma \quad (2)$$

Equation (1) can be written as

$$P_r = A_0 u^{-p} [I(u,p) - I(u(M/M_0)^{\beta-1}, p)] \quad (3)$$

where $A_0 = \frac{1}{2}\, a_0\beta \left(\frac{a_0\beta}{M_0}\right)^{p+2} \left(\frac{\beta-1}{3\beta-2}\right)^{p/2} \Gamma(p+1)$;

$$p = \frac{2\beta-1}{\beta-1};\quad u = \frac{a_0\beta}{M_0}\sqrt{\frac{\beta-1}{3\beta-2}}\,.\,r;$$

$$I(u,p) = \frac{1}{\Gamma(p+1)} \int_0^{u\sqrt{p+1}} e^{-v} v^p dv.$$

The function $I(u,p)$ is the incomplete gamma function which has been tabulated over an extended range of the values of u and p by Pearson[4], so that the laborious graphical integration required by equation (2) can be avoided.

Moreover, inspection of equation (3) shows that if β is constant (that is, p is constant) and if M/M_0 (the fraction unconverted) is constant, then P_r can be expressed solely as a function of u provided A_0 (which is a function of M_0 and a_0) be suitably adjusted. Therefore, it follows that it is unnecessary to calculate P_r separately for different values of a_0, M_0 (when β and M/M_0 are constant), since the curves of P_r against r or rP_r against r can all be derived

from a single one by a suitable multiplication of the scale of the r and P_r co-ordinates.

It is not possible to derive any simple expression for the value of r at which the maximum occurs in the rP_r against r curve, but it is possible to derive such a relationship for the occurrence of a maximum in the $r^{(2\beta-1)/(\beta-1)}P_r$ against r curve by simple differentiation. The maximum occurs at

$$r = \frac{M_0}{a_0\beta}\,\frac{3\beta-2}{(M/M_0)^{\beta-1}-1}\,\ln\,(M/M_0). \qquad (4)$$

Comparison of the calculated value of r from equation (4) with that derived from the experimental values of Evans gives $9{\cdot}2 \times 10^3$ calculated compared with 10×10^3 experimental. The agreement is rather better than the fit of the experimental and calculated curves from equation (3) as measured by the maximum in the rP_r against r curve, which occurs at $4{\cdot}5 \times 10^3$ (experimental) and at $3{\cdot}0 \times 10^3$ (calculated).

Thus it can be seen that by adopting the earlier general treatment, not only can the integration be expressed in terms of the well-tabulated incomplete gamma function, but also the variation of distribution with concentration of monomer and initiator can readily be derived. Further, this approach enables an additional test between theory and experiment to be made.

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A. Robertson
National Animal Breeding
Research Organisation,
Hendon, Middlesex.

[1] Baxendale, Evans and Kilham, *Trans. Farad. Soc.*, **42**, 668 (1946).
[2] Baxendale, Bywater and Evans, *Trans. Farad. Soc.*, **42**, 675 (1946).
[3] Herington and Robertson, *Trans. Farad. Soc.*, **38**, 490 (1942).
[4] Pearson, "Tables of the Incomplete Gamma Function" (H.M. Stationery Office, 1922).

Ionic Exchange and Fibre Contraction

A $0{\cdot}2\,N$ aqueous solution of sodium alginate (molecular weight $\sim 10^5$) was extruded into $1\,N$ hydrochloric acid, thus producing alginic acid fibres, which were converted into calcium alginate by immersion in $M/10$ calcium acetate. The well-washed calcium alginate threads, fully swollen with water, contained $0{\cdot}37 \times 10^{-3}$ gm.-equiv. calcium per gm., the ratio of equivalent calcium to equivalent water-insoluble acid was 1·0, and the dry weight was about 8 per cent. These fibres were opaque, slightly elastic, birefringent and capable of heterogeneous cation exchange reactions in which a replacement of the calcium by other cations takes place.

During the study of this ion exchange under continuous flow conditions[1], it was observed that on replacement of the calcium by sodium or potassium a striking change of shape of the fibres takes place. An experiment of this kind was as follows. A calcium alginate thread, fully swollen with water, and 0·4 mm. in diameter, was hung over a hook and rinsed with $1\,N$ sodium carbonate, at a rate of flow of 2·0 cm.³/sec. During this treatment an initial contraction of the fibre, followed by a lengthening, took place, as shown below:

Time from start of flow (sec.)	0	5	10	20	30	40	50	60
Length of fibre (cm.)	14·0	13·4	13·0	12·6	12·2	12·5	13·2	14·6
Contraction (%)	0	4·5	7	10	13	11	5·5	−5

After 60 sec., the experiment was interrupted in order to weigh the fibre; there was an increase of weight of about 20 per cent. In a control experiment, analyses were carried out after 30 sec., when the maximum contraction had occurred, and it was found that 29 per cent of the calcium had been converted into calcium carbonate, with simultaneous formation of sodium alginate. In estimating the calcium carbonate formed in this double decomposition, the fibre was immersed in water, and carbon dioxide was bubbled through the suspension; the calcium carbonate was thus quantitatively converted into the soluble calcium bicarbonate, while the undecomposed calcium salts were treated with $1\,N$ hydrochloric acid, the calcium thus liberated being separately determined.

A similar shortening of various alginate fibres is also brought about by solutions of alkali phosphates, fluorides, oxalates or citrates. In some of these experiments, the contraction was as large as 20 per cent of the original fibre-length, and the weight of the fibre did not change during the shortening. The birefringence of the fibre decreased during the contraction, while the elasticity and the transparency increased. A few preliminary tests were also done under isometric conditions, when a force of at least 3 gm./mm.² was observed.

In attempting to explain these effects, it is assumed that the bivalent calcium ions form salt bridges between adjacent alginate chains, thereby building up a three-dimensional network in which the chains formed by repeating d-mannuronic acid residues must be relatively straight. On replacing some of the calcium by alkali ions, gel segments will be liberated, which are more flexible than the completely 'vulcanized' structure. The segments will be able, therefore, to take up configurations which are statistically more probable and in which the chains are curled up to a certain extent; this will lead to a shortening of the fibre as a whole. The results obtained with other alginate fibres can be explained along similar lines, but it is not always possible to specify the nature of the inter-molecular cross-links.

In general, the contraction is regarded as a partial gel-sol transition, an interpretation which is also in accordance with the observed change of birefringence, transparency and elasticity. An important condition for fibre contraction appears to be that the replacement of calcium by alkali ions occurs rapidly. A number of experiments, to be described elsewhere, indicate that on slow replacement of the calcium by alkali ions no appreciable contraction of the fibres occurred, which is probably due to a predominating influence of plastic flow. The latter effect is perhaps mainly responsible for the lengthening of the fibres after contraction, but other reactions may also play a part during this stage of the ionic adsorption.

This investigation is being continued and extended to the study of protein and nucleoprotein fibres.

We are grateful to Prof. A. V. Hill for his interest in this work and to the Department of Scientific and Industrial Research for financial assistance.

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London, W.C.1.
March 25.

[1] This technique is similar in principle to that used in chromatographic adsorption analysis, and has also been used for an investigation of the cation exchange properties of the Brown Algæ from which the sodium alginate is extracted. See Wassermann, paper submitted to *Proc. Roy. Soc.*

Stability of Penicillin in Aqueous Solutions

WORK conducted in 1945 in the research laboratories of the Admiralty, but not then published, suggested that partially purified penicillin (calcium) from surface culture was more stable than the crystalline material. In addition, it was not found that phosphate, when included in penicillin solutions, produced any definite increase in the stability of the antibiotic.

The experiments were primarily carried out to obtain some information on the effect of solutions of different hydrogen ion concentrations on typical commercial samples of calcium penicillin as then being distributed at a potency of 362 units/mgm. Only when this work was under way did any information appear on the stability of penicillin solutions to various acidities. This work[1], however, applied to the crystalline sodium penicillin from submerged culture and stated that the pure material was more stable than the partially purified penicillin.

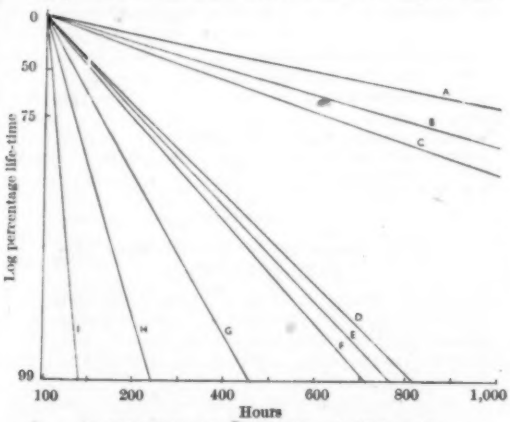
In the present work the stability of calcium penicillin was determined at each *p*H value from 2·00 to 10·0 in buffer solutions, these latter comprising:

*p*H 2·00 potassium chloride—hydrochloric acid.
3·00 potassium hydrogen phthalate and hydrochloric acid.
4·10, 5·00, 6·00 potassium hydrogen phthalate—sodium hydroxide.
6·00, 7·00 potassium dihydrogen phosphate—sodium hydroxide.
8·00, 9·00, 10·00 boric acid—sodium hydroxide.

These were selected experimentally, and found to be most suitable for the work, in preliminary experiments in which the temperatures were only approximately maintained at the specified levels. All buffer solutions were checked immediately prior to use against a standard buffer solution of known value on a meter.

The experiments at 4° C. were conducted in the refrigerator as this provides the usual storage place; those at 27·7° C. and 37·4° C. being thermostatically controlled in water baths.

Two samples of the sterile dried calcium salt were dissolved in separate bottles of the required buffer solution at the specified temperature, the final concentration being 500 units/ml. One bottle was utilized for removal of samples for assay, the second being used to determine the variation, if any, of the *p*H during the experiment. Samples were removed from the first bottle into ice-cold buffer mixture so that the final *p*H was about 6·5, at which the sample was stable for assay. The assays were carried out by the absorptiometer method in addition to the cylinder plate process, both employing *S. aureus* as the test organism. The *p*H and sterility of both bottles were determined at the conclusion of the experiment.



A, *p*H 5, 4° C.; *B*, *p*H 7, 27° C.; *C*, *p*H 6, 27° C.
D, *p*H 7, 37° C.; *E*, *p*H 4, 4° C.; *F*, *p*H 6, 37° C.
G, *p*H 5, 27° C.; *H*, *p*H 8, 27° C.; *I*, *p*H 3, 4° C.
Graphs for other values have been obtained similarly.

Results. Concentrations of penicillin were plotted against time for each of the temperatures and *p*H values. From the graphs the life-times of the antibiotic were expressed as percentages of the initial concentration.

LIFE-TIME OF PENICILLIN IN HOURS

Temperature	4° C.		27·7° C.		37·4° C.	
	99%	50%	99%	50%	99%	50%
*p*H 2·00	14·4	2·15	1·24	0·2		
3·00	78·55	11·83	6·36	0·95		
4·10	773·0	114·0	72·0	11·0		
5·00		562·0	462·0	70·0		
6·00				334·0	712·0	107·0
7·00				402·0	820·0	126·0
8·00			241·0	36·0	74·6	11·3
9·00			64·7	9·7		
10·00			14·6	2·2		

Omissions indicate that no experiments were carried out at the particular temperature, or alternatively, at *p*H 5, 6, 7, the samples proved so stable that the experiments were discontinued after obtaining the 50 per cent life-times.

These life-times are shown in the accompanying table, which indicates the 50 per cent and 99 per cent life-times of calcium penicillin at the various *p*H values and temperatures. The figures illustrate the more rapid inactivation of the drug in alkaline than in acid solution in the range tested.

Penicillin proved so stable at *p*H 5·00–7·00 that no accurate experimental results were attempted for 99 per cent life-time of penicillin at *p*H 5·0 and 4° C. Likewise at *p*H 6·0 and 7·0 at 4° C. and 27·7° C.

In contrast to other workers it was found here that penicillin was more stable at *p*H 7·00 than 6·00, but whether this is due to an increased stabilizing effect of phosphate at the higher *p*H only is not certain. This higher stability at *p*H 7·00 is clearly shown at both temperatures. Furthermore, the pure sodium penicillin appeared to be less stable by direct comparison with partially purified penicillin (calcium) at 24·3° C., and also by indirect tests at 27·7° C. At *p*H values of 3, 4, 5, 9, 10, where temperatures of 27·7° C. and 37·4° C. only were employed, even indirect comparisons with the pure material of other workers were not legitimate due to the length of time occupied by the life-times of penicillin.

At *p*H 6·0 and 7·0 (both 27·7° C. and 37·4° C.), however, the calcium penicillin used here proved more stable than the pure sodium salt is stated to be at 24° C. and 37° C. Possibly the impurities act catalytically, being more active in alkaline than in acid solution and perhaps also being inert or 'stabilizers' in neutral solution.

Summarizing, it may be stated that the partially purified penicillin employed here is more stable in solution than the crystalline material is believed to be. That this increased stability is not due to the different type of salt used seems evident from the extensive work on penicillin salt stability published elsewhere[2].

In reference to the phosphate effect on stability, it may be noted that none of the buffer solutions had any deleterious action on penicillin. At *p*H 6·0 and 7·0, phosphate buffer solutions were employed, and a recent communication[3] suggests that some stabilization had been effected by these ions. Whether this was so may be judged from experiments carried out here at *p*H 6·0 using both a phosphate and a non-

phosphate buffer solution for this acidity. In only one instance out of five did any slight increase in the life-time appear with the phosphate buffer as compared with the other solution. This, however, may have been due to an effect similar to that described recently[4], which stated that although remarkable success followed stabilization of sodium penicillin with phosphate, it was impossible to produce similar satisfactory results with calcium penicillin solutions.

I should like to express my gratitude to Surgeon-Captain Mussen, R.N., for permission to publish this work.

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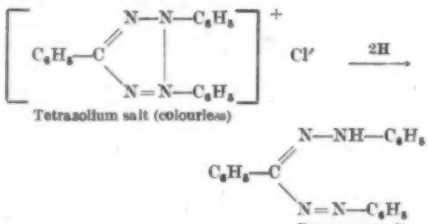
[1] Coghill, R. D., *J. Bact.*, **49**, 85 (1945); **51**, 291 (1946).
[2] Randall, W. M., *J. Amer. Pharm. Assoc.*, **15**, 7 (1945).
[3] Pulvertaft, R. J. U., *Nature*, **156**, 82 (1945).
[4] Pratt, R., *Nature*, **159**, 233 (1947).

Tetrazolium Salt as a Seed Germination Indicator

A TOPOGRAPHICAL chemical test for germination was devised by Lakon[1] using sodium biselenite, which, on account of its toxicity, he rejected in favour of the tetrazolium salts[2]. Later, he evolved a technique for maize[3] with 2,3,5-triphenyl tetrazolium chloride, which was used in Germany during the War[4]. As information about other cereals was inadequate, a preliminary assessment of this compound as a germination indicator has now been made.

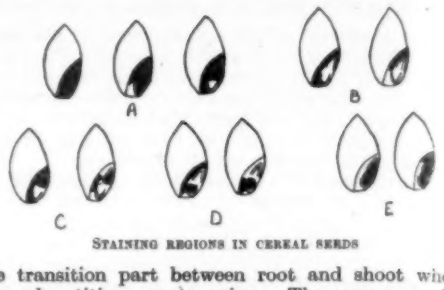
This tetrazolium salt is colourless, non-toxic, water-soluble, and easily reduced by either chemical or phytochemical means[5] to the triphenylformazan, an insoluble red dye.



When treated with an aqueous solution, the living tissues of germinating seeds are stained red; the conditions of the test being so arranged that the chemical processes of germination have already begun. In cereal seeds the whole of the embryo becomes stained, leaving the endosperm unaffected; whereas dicotyledonous seeds are stained completely.

The seeds are soaked in tap water overnight (18 hr.). Then they are cut through longitudinally in order to bisect the embryo. One half only of each seed is placed in a Petri dish (7 cm.), which just holds 100 grains or vetches, or 25 peas. Tetrazolium salt solution (1 per cent) is poured over them until every seed is just covered, and they are allowed to soak in the dark at 20° C. for 4 hr. The viable seeds have by now become stained, so the solution is poured off and the seeds, after washing with water, are examined individually.

In cereals other than maize, ability to germinate normally is indicated by staining of at least one half of the scutellum, the whole of the shoot part, and



STAINING REGIONS IN CEREAL SEEDS

the transition part between root and shoot where the adventitious roots arise. The accompanying diagram indicates the types of staining encountered; only those in *A* are capable of normal germination. The same technique has been applied to peas and vetches.

A few typical results are set out in the accompanying table and compared with results obtained by the standard laboratory method.

COMPARISON OF TETRAZOLIUM AND GERMINATION TESTS

Seed	% Seeds capable of normal germination	
	Tetrazolium test	Standard germination test
Oats	85	88
Barley	97	98
Wheat (*a*)	99	99
(*b*)	39	40
Peas	97	97
Vetches	70	66

In the tetrazolium test, results are obtained within 24 hours as compared with ten days or more for the standard laboratory germination test. At the same time, latent causes of abnormality can be observed without any specialized botanical knowledge or skill, or elaborate apparatus. The method is more exacting and time-consuming for the individual worker, but against this must be set the advantage of obtaining a speedy evaluation of seed viability, either as a final or merely as a screening test.

A fuller account of this work will be published elsewhere.

I would like to express gratitude to Mr. C. C. Brett of the Official Seed Testing Station for his advice, and to the directors of May and Baker, Ltd., for permission to publish this communication.

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Research Laboratories,
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Dagenham.

[1] Lakon, G., *Ber. deut. bot. Ges.*, **57**, 191 (1939).
[2] Lakon, G., *Ber. deut. bot. Ges.*, **60**, 299 (1942).
[3] Lakon, G., *Ber. deut. bot. Ges.*, **60**, 434 (1942).
[4] C.I.O.S. Report, Item 24, No. XXVI-73.
[5] Kuhn and Jerchel, *Ber. deut. chem. Ges.*, **74B**, 941.

New Aspects of the Action of Methylthiouracil

G. MANSFELD demonstrated[1] that in the serum of overheated animals a substance, thermothyrine A, is present which, injected into normal animals, decreases oxygen consumption. Serum of thyroidectomized animals has no effect.

I have shown[2] that thyroidectomized guinea pigs react to high environmental temperature by a more rapid, higher and prolonged hyperthermia than normal animals. This effect is not due to lack of thyroxine, because thyroxine enhances the effect of

thyroidectomy on this reaction. Therefore, lack of thermothyrine A must be assumed as an explanation.

The fact that in later experiments similar results were obtained in animals treated with methylthiouracil raised the question whether methylthiouracil not only inhibits the formation of thyroxine but also the production of thermothyrine.

Dogs and rabbits were treated daily with 0·10 gm. per kgm. methylthiouracil for four weeks, and were then subjected for five hours to a temperature of 34–35° C., which raised their body temperature by 0·5–1·5° C. 2·5 c.c. of serum obtained at the end of the 5-hour period failed to reduce oxygen consumption of normal rats, while sera of untreated dogs and rabbits produced after similar exposure to high temperature a fall of oxygen consumption by 14–48 per cent. It is therefore evident that methylthiouracil inhibits the formation of both thyroxine and thermothyrine A.

The fact that thermothyrine A contains no iodine[3] proves conclusively that the action of thiouracil compounds cannot be exclusively an inhibition of iodinization.

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Experimental Pathology,
University of Pécs.
Feb. 28.

[1] Mansfeld, G., "Die Hormone der Schilddrüse und ihre Wirkungen" (B. Schwabe and Co., Basel, 1943).
[2] Berde, B., *Experientia*, **2**, 498 (1946).
[3] Mansfeld, A., *Nature*, **157**, 491 (1946); and *Schweiz. Med. Wschr.* (1946).

A Rapid Supra-vital Staining Method for Assessing the Viability of Human Spermatozoa

We have developed a 4-minute technique for the supra-vital staining of spermatozoa which facilitates the estimation of viability and at the same time is suitable for the examination and counting of abnormal forms.

The method is based on the principle of Emmens[1] for rabbit spermatozoa which, however, is unsuitable for human material.

Method : Supra-vital stain, 50 c.c. distilled water; 1 gm. Revector Soluble Blue 706; 1·5 gm. glucose; 0·1 gm. sodium chloride; 0·3 gm. disodium hydrogen phosphate, hydrated; 0·005 gm. potassium dihydrogen phosphate, anhydrous. (This solution must be made up freshly, or alternatively it may be stored in 1 ml. ampoules and autoclaved.)

Counterstain : 1 per cent neutral red in distilled water.

Fixative : Half-volume saturated solution of mercuric chloride in distilled water; half-volume absolute alcohol; followed by 90 per cent alcohol containing a few drops of iodine in potassium iodide to give straw-coloured solution.

Four or five drops of seminal fluid are placed on a clean slide or in a small tube, and one drop of the supra-vital stain is added and well mixed. The mixture is left for 2–3 min. and one drop is withdrawn and a thin smear is made on a clean dry slide. The smear is allowed to dry in air, and is then fixed in the above fixative for 15–20 sec.; the slide is then dipped into alcoholic iodine, and into 90 per cent alcohol, and allowed to dry. The counter-staining is effected by putting the slide into neutral red for 15–30 sec., rinsing in water and differentiating *with care* in 90 per cent alcohol. The smear may then be dried and examined directly under oil immersion, or it may be passed through absolute alcohol and xylol and mounted in Canada balsam.

The nuclei of the spermatozoa which were dead when the seminal fluid was mixed with the stain are blue or purple; those that were alive are *clear* red, and a few non-nucleated forms remain unstained.

The stain does not kill living spermatozoa, since the motility of spermatozoa mixed with the soluble blue–Baker's fluid solution is unaffected. We have found motile spermatozoa in the stain after a period of 36 hours. The decrease in motility of sperm in the stain solution is of the same order as that of sperm in its own seminal fluid.

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Anita M. Mandl

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London, E.1.
April 3.

[1] *J. Physiol.* in the press.

Two Symbiotes of *Psylla mali*

As a representative of Psyllid I selected *Psylla mali*, which, feeding on the apple tree, was easily available for investigation, and also for confirmatory work by other investigators. Profft[1] has published the best account that has appeared on symbiosis in this group of insects. On p. 312, in Fig. 19, he illustrates a section of the bacteriotome, called by him, in conformity with others, a mycetome. Unfortunately, the magnification of the section is only 165, which is exceptionally low for any cytological study. Further, he does not give any illustration of the symbiotes as seen in a smear of the tumour. In his illustration the majority of the tumour cells contain curved dark-staining objects. When I studied them in smears, stained with Giemsa, they appeared to be thick comma-shaped bacteria.

Profft's illustration, Fig. 19, also shows some tissue cells faintly stained, with contents very indistinct. These tumour cells contain very delicate and short bacteria which are best seen in smears stained with Giemsa.

A medium with apple juice was used for cultivating the symbiotic bacteria. The thick comma type of bacterium produced a bright green pigment like the colour of the insect. Morphologically, the tissue smear and that from the bacterial growth were identical. I noticed a cherry tree accidentally infected with *Psylla mali*; the insect which is usually green was now brownish-red. I made another medium with cherry extract. The medium was faintly coloured dirty pink. On plating, the comma-shaped symbiote of *P. mali* produced a bright cherry colour, like the colour of the insect feeding on the cherry tree. The share of the bacterium in producing a pigment derived from the food was thus evident. The minor symbiote, the delicate bacterium, did not produce any pigment, and its role in the economy of the insect was not discovered.

This work was done some years ago, at Berlin, in the laboratory of Prof. F. F. Nord, now at Fordham University, New York. It is a pleasant duty to acknowledge his interest again here.

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Hyderabad.
March 5.

[1] *Z. Morph. u. Ökol.*, **32**, 312 (1937).

APPLIED BIOLOGY IN THE LEATHER INDUSTRY

THAT the leather industry forms an extensive field for research in applied chemistry has been well known for many years; that it forms a field, at least as extensive, for research in applied biology has been less well appreciated; and this notwithstanding the facts that the raw material of the industry is animal skin, that oils used by the industry and many tanning agents are plant products, that bacteria and moulds play havoc with certain of the processes of manufacture, and that insects cause damage to stored hides and finished leather. Clearly, in such an industry there must be opportunities for research in animal histology and physiology, as well as in microbiology, entomology and biochemistry; and some account of the problems presented in these various fields was given in a symposium held on March 21 at the Imperial College of Science and Technology by the Association of Applied Biologists in conjunction with the British Leather Manufacturers' Research Association.

The symposium was introduced by Sir Robert Pickard, who outlined the elaborate processes of leather manufacture, laying emphasis on the biological aspects and remarking that the problems of the industry call for co-operation between the statistician, the chemist, the physicist, the biologist and the psychologist, and directed attention to the fact that the tanner is handicapped by his raw material, the animal skin, over which he has very little control, as it is a by-product of other industries.

Discussing the factors that affect the animal skin, Mr. J. N. Turner stated that until comparatively recently the quality of skins received by the tanner did not vary greatly, and production of leather resolved itself into a relatively simple routine; but nowadays, with a wider market of supply and with advances in breeding and feeding techniques, many of which favour the milk- or meat-producing qualities of an animal at the expense of the leather-making properties of its skin, very wide variations are liable to occur that may necessitate certain changes in manufacture and in the resulting product. An acquaintance with recent trends in agricultural genetics and animal husbandry is therefore important to a modern leather manufacturer. It is only within the last decade that any attempt has been made to ascertain and measure the effects on the skin of cross-breeding and intensive feeding: for example, South African work has shown the effect of breed variations on the wearing quality of sole leather from cattle hides, and other work has indicated the effect of intensity of feed upon the fat content of hide and its bearing on grease stains in the finished leather. Differences in skin may also result from variations in climate and topography, and artificial changes may be induced by sex hormones, silicic acid or by compounds that stimulate mitosis.

Collagen, or white fibrous tissue, is the chief component of the animal skin from the leather industry's point of view. To the collagen fibres are due the properties of a leather, such as its tensile strength and resistance to abrasion; and much time has been devoted to the study of collagen by histologists and biochemists. In presenting some problems associated with reticulin, elastin and collagen in the skin, Miss M. Dempsey and Miss M. E. Garrod said that elastin and reticulin possess an importance out of all proportion to their amount. For reticulin fibrils that bind the collagen fibres together have a restrictive effect upon the swelling of collagen during the wide *p*H variations of the tannery processes; and elastin, which occurs in the skin chiefly in both the papillary and the innermost layers, has a particular effect on that outer part of the skin that eventually becomes the 'grain' layer of the leather. One of the difficulties in their investigations was to isolate pure samples of the fibres from the animal skin; consequently work was done, for example, on reticulin from adipose tissue, elastin from ligamentum nuchæ, and on collagen from rat-tail tendon, the binding sheath of which consists of both elastin and reticulin. They are not certain, however, that findings on these easily accessible tissues are directly applicable to similar tissues in the skin.

That the study of the surface chemistry of the animal skin is of importance and interest to the industry was indicated by Dr. K. G. A. Pankhurst. The conversion of animal skin to leather involves the three main constituents of the skin: protein, lipoid and water. The globular proteins are largely removed, the fibrous proteins are chemically modified by tanning, the natural lipoids are usually removed at an early stage of the process and are replaced by others at the end, and the water content is considerably reduced. Dr. Pankhurst pointed out that the three phases allow of six possible interfaces: protein–lipoid, protein–water, protein–air, lipoid–water, lipoid–air, protein–air; and each presents peculiar problems to the tanner. Leather is composed of an interlacing network of fibres that creates a system of *quasi* capillaries; consequently, as it is always necessary to have a full control over the kind of liquid that flows through them, a knowledge of the chemistry and physics of the flow of liquids is important in many leather-making problems. The penetration of a liquid into a fibrous structure is dependent on (*a*) the adhesion between fibre and liquid, (*b*) the surface tension of the liquid, and (*c*) the size and spacing of the fibres in the surface. The effective angle of contact that the liquid makes with the skin is an index of the penetrability of the liquid into it: if the angle is 90° or less the liquid will flow through; if it is greater than 90° the liquid will not flow through unless a certain pressure is applied to it. Penetration problems arise in the soaking of dried skins, the removal of lipoids from wet skins, the re-introduction of lipoids after tanning, waterproofing, etc.

One of the more curious processes in leather manufacture is that of 'bating'. It is a pretanning process in which tryptic enzymes are allowed to act on the skin. When it is properly done a characteristic silky smoothness is produced in the finished leather. From the earliest days of the industry, bating has been done with the dung of certain animals; but in more recent times the use of these unpleasant materials has been largely replaced by the appropriate enzymes. In dealing with the use of enzymes in the industry, Dr. E. W. Merry confined his attention to the bating process. The enzymes are obtained chiefly from pig pancreas, but ox pancreas, fish viscera, bacteria and fungi are also used. It has been shown that a preparation of pure chymotrypsin from pancreas can produce a typical bated effect in a skin. However, the mixed proteolytic enzymes in a bate have various effects on the different skin proteins: it appears that they affect, to greater or lesser degrees, elastin, collagen, keratin and perhaps

reticulin, and it has been suggested that they have an important effect on the erector pili muscles in the skin. It seems not unlikely that, in the future, bates may be made up with specified enzymes, so that the different proteins of the skin may be preferentially attacked according to the class of leather desired.

Bacteria are notorious in the industry as the cause of putrefaction and, in the form of anthrax, as a danger to operatives. In their paper on this aspect, Dr. M. E. Robertson and Miss B. M. Haines said that putrefaction is usually prevented either by drying the hides after flaying or by treating them with sodium chloride as a preservative. The treatment of hides with a salt of marine origin, however, is likely to encourage a growth of red halophilic bacteria, known to tanners as 'red heat'; but this can be prevented by the addition of sodium fluoride to the salt. The use of disinfectants is also recommended in the process known as soaking, during which bacterial damage is especially common. The important process of liming kills all active stages of bacteria, but some spores (including those of anthrax) can survive; these can be killed by 'drumming' in lime and sodium sulphide at a raised temperature. Bacteria can, however, sometimes be of use to the industry: in America, bacteria producing lactic acid are used to promote the necessary acidity in the tan liquors, but in Great Britain the method is regarded as too difficult to control.

During many of the stages from skin to finished leather, mould fungi occur: except as a source of bating enzymes, they are a nuisance. The industry has also its insect pests, the chief being, perhaps, the beetles of the genus *Dermestes*. Mr. A. J. Musgrave, dealing with mycological and entomological problems, outlined the damage caused by fungi in the various processes. It is well known that vegetable-tanned leather is a better substrate for fungal growth than that which has been chrome-tanned; but the kind of processing a leather has received affects its liability to mould growth; moreover, there is need for a fuller acquaintance with the species of fungi that occur in the industry, and of the damage that they cause. A number of fungicides are available to the industry, which has wisely made use of available knowledge; and there are various ways in which fungicides can be incorporated in leather, though its multifarious uses make every proofing problem worthy of individual attention.

A considerable number of insects associated with the industry has been recorded. The chief pests seem to be warble flies, attacking the living skin, *Dermestes* beetles on dried hides, clothes-moths and carpet beetles on furs, and various insects attacking leather in the tropics. In addition, the fly *Piophila casei* is a considerable nuisance. It appears that the most systematic efforts at control have been those directed against *Dermestes* beetles: for many years arsenication of dried hides has been practised. The difficulties encountered in carrying out laboratory tests on insecticides and fungicides for the industry were discussed: some simple preliminary experiments have indicated that 'Gammexane' may be more toxic than D.D.T. to *Dermestes maculatus*.

Finally, when the leather has been manufactured, it may be found to be faulty in some way, or a tanner may realize during manufacture that there is some irregularity. A method in leather biology that is indispensable in investigating these faults and in controlling the various processes is a specialized branch of animal histology: the study of the fibre structure of skins and leather. In dealing with this subject, Miss M. Dempsey stipulated that it is the task of the student of fibre structure to attempt to correlate what he sees with the physical properties of the leather and with the kind of processing it has undergone. The condition of the collagen fibre bundles and their manner of interweaving constitutes, *sensu strictu*, the fibre structure of the leather: the history of a leather is written in the appearance of its fibre bundles. The properties of a leather, she said, are dependent on its fibre structure, the appearance of which not only gives information about the suitability of a process, but also indicates the quality of the leather, and, more important still, may reveal the cause of a flaw, such, for example, as skin disease or putrefaction, chemical breakdown during manufacture or maltreatment in use. The various features of fibre structure were described and their practical importance indicated.

A fuller account of this meeting is to be published in the *Annals of Applied Biology*.

RESEARCH AND INDUSTRY IN SCOTLAND

THE Scottish Regional Conference on "Research and the Progress of Industry in Scotland" arranged by the Federation of British Industries and held at the Merchants' Hall, Glasgow, on April 25, was on similar lines to that of the Midlands Regional Conference of the Federation at Birmingham in March. A message from Sir Edward Appleton wishing the Conference success contained, however, perhaps the most important statement made there. After indicating that the Department of Scientific and Industrial Research had been giving a good deal of attention to the question of the diffusion of scientific knowledge, and was looking to these conferences for guidance as to how best to deploy the limited scientific effort of Great Britain, Sir Edward said that to improve the Department's contacts with Scottish industry it is arranging to open a Scottish branch of the recently created Intelligence Division; and he cordially invited firms to discuss their special problems with the Department when that branch had been opened.

The morning session of the Conference considered the established industries of the region, Mr. W. Barr dealing with research in the steel industry, followed by Sir Wilfred Ayre on research in the shipbuilding industry and Mr. W. G. Marshall on research in the heavy engineering industries. Mr. Barr referred particularly to the recruitment of workers with technical knowledge in order that the results of research may be utilized. Steelmaking, so long practised as an art, is slowly becoming a science founded on the laws of physical chemistry, but much remains to be done before the desirable degree of control throughout the process is attained. Sir Wilfred Ayre, pointing out that the Scottish industry should not be differentiated from the larger British shipbuilding industry of which it is a part, suggested that the application of science in the industry would be facilitated if firms were readier to present the results of their research either in papers before technical institutions or to the industry's research association. He referred particularly to the valuable contribution of the various technical institutions, as well as to the work of the classification societies, and to the important

part which the technical colleges might take in research. Private firms, however, must continue increasingly to carry out scientific work for themselves, and increasing numbers of their technical staff will require a more scientific training; and he stressed the need for planning so as to ensure that research work is at all times adequately prosecuted undisturbed by fluctuations in the prosperity of the industry. Commenting on the special problems of Scottish heavy industry, Mr. Marshall emphasized its comparative isolation from other industrial areas, the lack of variety of technical facilities, and of the skilled manpower and brain-power provided by light industry. It is thus the more important that the industry should make the fullest use of existing technical facilities. After reviewing the functions of an industrial research department, including the necessity of keeping abreast of research and development work elsewhere, and the qualifications of its staff, he briefly outlined the problems with which the research department of Messrs. Babcock and Wilcox, Ltd., is concerned. No section is entirely devoted either to routine or to research, and physics is of increasing importance in almost every branch of technology.

At the afternoon session, which considered broadly the balancing of Scotland's industries, Dr. J. W. McDavid reviewed the experience of the Explosives Division of Imperial Chemical Industries, Ltd., with nitrocellulose finishes, 'Cellofas', ethylcellulose, pentaerythritol, 'Ardil', etc., to indicate the way in which a live research and development department leads to new manufactures loosely but logically connected with the main industry. Dr. W. M. Cummings' paper, "Chemical Research for Scottish Industry", considered especially the needs of the small manufacturer who is characteristic of the region. The region is not big enough industrially to have several different research organisations, and while Dr. Cummings referred to the idea of establishing a research organisation in Scotland, working in close association with the Department of Scientific and Industrial Research, covering all branches of industry, engineering, building, coal, food, etc., he appeared to look rather to the technical colleges for greater assistance, and in particular he commended the example of the Joint Research Council established in Manchester. The idea could be extended with advantage in other areas, and should promote the contacts between industry and the technical colleges and universities which are all-important.

Mr. J. N. Toothill, discussing "Research in the Light Engineering Industries", commented on the effect of research and development on export policy and its assistance in securing balanced employment. It also helps to raise the standard of living of the community, and it can be an important factor in determining the location of industry. Mr. Toothill dealt with this idea in some detail, suggesting that in a new light industry, the growth of new products arising out of technical discoveries and appreciation of their market possibilities, and communications with market centres and centres of research, are more important influences on the location of industry than the supply of cheap raw material, adequate modern factory facilities and adequate, cheap and reliable supplies of electric power. At present, Scotland employs only 2·5 per cent of the total scientific man-power of the United Kingdom, as against a working population of 10 per cent, and new industries fail to grow in all areas distant from London. In this connexion, he referred to the tendency in the United States, and to some extent in Great Britain, to segregate the direction of policy, market research and technical research in areas near the national headquarters, leaving production to be carried out where labour is available.

In the final paper of the Conference, Prof. R. Hay, reviewing the individual Scottish firm and its application of research, pointed out that the first essential is a desire on the part of firms to utilize the advances already made in technical research. For small firms he suggested first the engagement of a professional consultant. For larger firms a technical development officer might be employed as technical adviser to the head of the firm, working in conjunction with established research associations, possibly supplemented by a small staff of his own. To meet the dearth of qualified men a co-operative effort of technical colleges and industry would be required, while finally Prof. Hay urged that industry in Scotland could with advantage develop a research centre on the lines of the Mellon Institute.

EMISSION OF RADIO-WAVES BY THE GALAXY AND THE SUN

By JOSEPH S. SHKLOVSKY
Sternberg Astronomical Institute of the Moscow State University

THE remarkable investigations of Reber[1], Southworth[2] and Appleton[3] have shown that radio-waves in the metre and centimetre region are emitted by the galaxy and the sun. Henyey's and Keenan's theory of long-wave emission by the galaxy[4] is based on the assumption that the mechanism of this emission is a free-free emission from interstellar gas. However, they have not correctly accounted for the absorption of radio-waves in the galaxy. Besides free-free absorption (which Henyey and Keenan took into account), there is an ordinary absorption of radio-waves because of damping oscillations of electrons in the field of radio-waves. The coefficient of absorption is given by

$$\alpha_\nu = \frac{\pi e^2 N_e}{m} \cdot \frac{1}{c} \cdot \frac{\gamma}{4\pi\nu^2 + (\gamma/2)^2}.$$

In interstellar space (and even more so in the solar atmosphere) the constant of damping γ is determined by the collision of electrons with ions. In this case

$$\gamma = 4N_i\sqrt{\frac{2\pi kT_e}{m}} \cdot \frac{\pi}{2} \frac{e^4}{(kT_e)^2} \ln \left(\frac{3}{2}\frac{kT_e}{e^2 N_e^{1/3}}\right),$$

where $N_i = N_e$, the concentration of ions, and T_e is the electron temperature.

Solving the equation of transfer, we get the following expression for the intensity of galactic radio-emission:

$$I_\nu = \frac{2\nu^2 kT_e}{c^2}\ (1 - e^{-\tau_\nu}),$$

where τ_ν is the optical depth of the galaxy in a given direction. Here the coefficient of absorption is accounted for in the above-mentioned manner.

Each intensity of a given optical depth of the galaxy in a given direction measured by Reber can be brought to a mutual correspondence. Assuming that $T_e = 10{,}000°$, we find that the above-mentioned τ_ν changes from 0·48 (in Sagittarius, where the intensity is the highest) to 0·008 (in Perseus). For most regions of the Milky Way τ_ν is less than 0·1.

Eddington and, in more detail, Strømgren showed[5] that interstellar hydrogen is ionized in the so-called zones of ionized hydrogen which surround the hot stars. According to Strømgren, the ratio of the volume of the zones of ionized and unionized hydrogen is 1/9. In the zones of ionized hydrogen N_e is[6] of the order of 2–4/cm.^{3}; in the zones of unionized hydrogen N_e is at least a hundred times smaller. Therefore, the zones of unionized hydrogen practically do not have any influence on the long-wave emission of the galaxy, as their optical depth is negligibly small. If the above-mentioned estimation of the ratio of both zones were correct, τ_r would be much larger in all directions in the galaxy than those determined by Reber.

It can be supposed that the volume of the zones of ionized hydrogen given by Strømgren is too large. Strømgren extrapolated the relative number of hot stars observed in the vicinity of the sun to the whole galaxy. However, according to Baade[7], hot stars belong to the so-called 'first type' of population of the galaxies and are found only on the borders of the latter.

The optical depth of the solar atmosphere for radio-waves of different wave-length can be calculated. The optical depth of the chromosphere for $\lambda = 1$ cm. is 3×10^3; for $\lambda = 10$ cm., it is 3×10^5; and for $\lambda = 187$ cm., it is 10^6. Therefore, the chromosphere is not transparent for radio-waves. The optical depth of the corona for the same wave-lengths is correspondingly $1{\cdot}2 \times 10^{-4}$, 0·013 and 4·5, assuming that the electron temperature of the whole corona $T_e = 350{,}000°$[8]. Therefore, the radiation in the centimetre range observed by Southworth is emitted mainly by the top layers of the chromosphere, that of the metre region (Reber) by the corona. However, if the temperature of the electrons of the whole corona were equal to 350,000°, the radio emission would be at least one hundred times larger than that measured by Reber. In order to bring theory and observations into accordance, it is necessary to assume that the electron temperature of the outer corona is relatively low and equal to about 3,500°. In this case the optical depth of the outer corona ($R/R_\odot > 3$) will be equal to 4·6. The outer corona will absorb intensely the radio emission of the 'hot' inner corona; its own emission will correspond to low temperature.

Recently Appleton[3] ascertained that at times the sun emits radiation 7 m. $< \lambda < 30$ m., the intensity of which is at least 10^4 times more than the intensity of a black body at $T = 6{,}000°$. He connects this with bright eruptions in the solar atmosphere. This phenomena evidently could not take place if the emitter were a black body.

We suppose that in this case the proper vibrations of the plasma of the outer corona are the cause of radiation. This is based on the astonishing coincidence of the frequency of proper vibrations of the plasma given by Langmuir's formula:

$$\omega_L = \sqrt{\frac{4\pi e^2 N_e}{m}}$$

with that observed by Appleton's fellow-workers. Linder[9] showed that it was possible for longitudinal waves to be propagated in the plasma with a frequency close to ω_L. Every vibrating electron will emit radiation of frequency ω_L. This phenomena was observed by Penning[10], Ditmer[11] and others.

Proper vibrations of plasma may be caused by a flow of charged corpuscles, which move through the corona with a velocity more than that of sound. This was observed experimentally by Merill and Webb[12]; Vlasov[13] worked out a theory explaining the loss of energy of charged particles through their exciting proper vibrations. If the concentration of fast corpuscles necessary for exciting vibrations of the observed power is calculated, taking this theory as a basis, the derived values are fully reasonable.

If the proposed theory is correct, there must be a magnetic storm about one day after the outburst of the anomalous radio emission. After the above was written, I learned that this had been observed[14]. Another result of this theory is that the sun should emit, to a great extent, radiations in the decimetre range caused by proper vibrations of the plasma of protuberances and upper chromosphere. The corona only slightly absorbs this radiation. The 'decimetre' and 'metre' radiations should arise almost simultaneously. Entirely new possibilities for predicting geophysical phenomena are therefore revealed.

Details of this investigation are given in the *Russian Astronomical Journal*, **23**, No. 6, 333.

[1] *Astrophys. J.*, **100**, 279 (1944).
[2] *J. Franklin Inst.*, **239**, 285 (1945).
[3] *Nature*, **156**, 635 (1945).
[4] *Astrophys. J.*, **91**, 625 (1940).
[5] *Astrophys. J.*, **89**, 526 (1939).
[6] *Astrophys. J.*, **88**, 364 (1939); **90**, 119 (1939).
[7] *Astrophys. J.*, **100**, 137 (1944).
[8] *Z. Astrophys.*, **3**, 199 (1933).
[9] *Phys. Rev.*, **49**, 753 (1936).
[10] *Physica*, **6**, 241 (1926).
[11] *Phys. Rev.*, **28**, 507 (1926).
[12] *Phys. Rev.*, **55**, 1191 (1939).
[13] *Sci. Letters Moscow State Univ.*, **75** (1945).
[14] *Nature*, **157**, 46, 48 (1946).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 2

UNIVERSITY COLLEGE, LONDON (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. R. O. Kapp: "The Presentation of Technical Information" (other lectures will be given on June 9, 16 and 23).*

Tuesday, June 3

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Rev. W. J. Culshaw: "The Santals of Western Bengal".

Wednesday, June 4

PHYSICAL SOCIETY, COLOUR GROUP (at the Lighting Service Bureau, E.L.M.A., 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. H. G. W. Harding: "The Colour Temperature of Light Sources".

INSTITUTE OF PETROLEUM (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. R. P. Russell: Second Cadman Memorial Lecture.

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. Magnus Pyke: "Nutrition in Post-War Germany and Austria" (members of the Food Group are invited).

Thursday, June 5

FEDERATION OF BRITISH INDUSTRIES (at the Royal Victoria Hotel, Sheffield), at 10 a.m.—Regional Conference on "Industry and Research".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Thomas Merton, F.R.S.: "On Interference Microscopy"; Dr. S. Tolansky and Mr. W. L. Wilcock: "Interference Studies of Diamond Faces—A Crossed Fringe Technique".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, June 6

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the ROYAL SANITARY INSTITUTE, at the Torquay Natural History Museum, Babbacombe Road, Torquay), at 10 a.m.—Discussion on "The Microbiological Aspects of Food Quality" (to be opened by Prof. H. D. Kay, F.R.S.). (Meeting will constitute the Food and Nutrition Section of the Health Congress.)

INSTITUTION OF THE RUBBER INDUSTRY (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 5.30 p.m.—Dr. Philip Schidrowitz: "The Impact of Synthesis on the Rubber Industry" (Second Foundation Lecture).

CHEMICAL SOCIETY, HULL LOCAL SECTION (joint meeting with the UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the Assembly Hall, University College, Hull), at 6.15 p.m.—Sir Ian Heilbron, F.R.S.: "Some Aspects of the Chemistry of Penicillin" (Inaugural Lecture).

Tuesday, June 3—Friday, June 6

INSTITUTE OF FUEL (at the Royal Hall, Harrogate).—Conference on "Pulverised Fuel".

Tuesday, June 3

At 10.30 a.m.—Opening of the Conference; at 2.30 p.m.—First Session.

Wednesday, June 4

At 10 a.m.—Second Session; at 2.30 p.m.—Third Session.

Thursday, June 5

At 9.30 a.m.—Fourth Session.

Friday, June 6

At 10 a.m.—Fifth Session; at 2.30 p.m.—Closing Session.

INSTITUTE OF WELDING (at King's College, Newcastle-upon-Tyne).—North-East Coast Meeting. Visits and Technical Papers.

Saturday, June 7

BIOCHEMICAL SOCIETY (in the Medical School, Hospitals Centre, Birmingham), at 1.30 p.m.—Scientific Papers.

Sunday, June 8

INSTITUTE OF ECONOMIC ENGINEERING (at the Waldorf Hotel, Aldwych, London, W.C.2), at 2.30 p.m.—Mr. E. H. Lewis: "Factors Affecting Output per Man-Hour".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR ASSISTANT IN METALLURGY in the Bradford Technical College—The Director of Education, Town Hall, Bradford (June 7).

LECTURER (temporary) IN ZOOLOGY—The Secretary, University of Durham, 38 North Bailey, Durham (June 7).

LECTURER IN CIVIL ENGINEERING, a LECTURER IN MATHEMATICS, a LECTURER IN PHYSICS, a LECTURER IN CHEMISTRY, a LECTURER IN BIOLOGY, and a LECTURER IN ELECTRICAL ENGINEERING, at the Brighton Technical College—The Education Officer, Education Office, 54 Old Steine, Brighton 1 (June 7).

JUNIOR PHYSICIST to take part in the clinical, teaching and research work of the Physics Department, and a PHYSICIST to assist in research on application of physics to medicine—The Secretary, Royal Cancer Hospital (Free), Fulham Road, London S.W.3 (June 9).

LECTURER IN MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (June 9).

PRINCIPAL SCIENTIFIC OFFICER at the Royal Observatory, Blackford Hill, Edinburgh—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1916 (June 10).

ASSISTANT REGISTRAR—The Secretary, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (June 13).

PROVINCIAL SPECIALIST ADVISORY OFFICERS, ASSISTANT ADVISORY OFFICERS, and DISTRICT ADVISORY OFFICERS, in the National Agricultural Advisory Service—The Secretary, Ministry of Agriculture and Fisheries, 4 Bickenhall Mansions, London, W.1, endorsed 'N.A.A.S.' (June 14).

MAY AND BAKER RESEARCH FELLOWSHIP in the Department of Physical Sciences—The Registrar, Wye College, Wye, Ashford, Kent (June 14).

LECTURER IN BIOLOGY, and a LECTURER IN CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (June 14).

CHEMIST to take charge of the Plant Protective Chemistry Section—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (June 14).

LECTURER IN APPLIED MATHEMATICS—The Registrar, King's College, Newcastle-upon-Tyne (June 14).

ASSISTANT PSYCHOLOGIST in the Research Unit of the Civil Service Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1890 (June 14).

DEMONSTRATOR IN CHEMICAL PATHOLOGY—The Registrar, The University, Leeds 2 (June 15).

GRISEDALE SCHOLARSHIP FOR RESEARCH IN BOTANY OR ZOOLOGY—The Registrar, The University, Manchester (June 20).

ASSISTANT PHYSICIST IN THE RADIOTHERAPY DEPARTMENT—The House Governor, London Hospital, Whitechapel, London, E.1 (June 20).

ASSISTANT LECTURERS IN PHYSICS and GEOLOGY, RESEARCH DEMONSTRATORS (part-time) IN PHYSICS and CHEMISTRY, and an ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Singleton Park, Swansea (June 21).

LECTURER IN GEOLOGY, a LECTURER IN PHYSIOLOGY, and a DEMONSTRATOR IN GEOLOGY—The Secretary, Queen's University, Belfast (June 21).

ASSISTANT KEEPER IN EGYPTOLOGY in the Manchester Museum—The Registrar, The University, Manchester 13 (June 21).

LECTURER IN PHYSICAL CHEMISTRY—The Registrar, The University, Reading (June 23).

LECTURER IN PHYSICS—The Registrar, The University, Manchester 13 (June 28).

AGRICULTURIST, and a PLANT BREEDER, in the Department of Agriculture, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (June 30).

ASSISTANT LECTURER IN GEOLOGY—The Registrar, The University, Reading (June 30).

PRINCIPAL RESEARCH OFFICER IN THE ENGINEERING DIVISION of the National Building Research Institute—The Secretary-Treasurer, Council for Scientific and Industrial Research, Private Bag 188, Pretoria, South Africa (June 30).

BOTANIST—The Director, Imperial Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (June 30).

DIRECTOR OF SUGAR TECHNOLOGICAL RESEARCH at Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (June 30).

McROBERT RESEARCH FELLOW to undertake research relating to any disease that is generally regarded as malignant or incurable in Bacteriology, Biology, Chemistry, Chemotherapy, Clinical Science, Pathology or Physics—The Secretary, The University, Aberdeen (June 30).

LECTURER IN CIVIL ENGINEERING, and a LECTURER IN MECHANICAL ENGINEERING—The Director, Robert Gordon's Technical College, Aberdeen (June 30).

CHAIR OF ANATOMY at Charing Cross Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 1).

SENIOR LECTURER, a LECTURER or ASSISTANT LECTURER, and an ASSISTANT LECTURER or DEMONSTRATOR, IN THE DEPARTMENT OF GLASS TECHNOLOGY—The Registrar, The University, Sheffield (July 1).

PROFESSOR OF BOTANY, a PROFESSOR OF ZOOLOGY, and a PROFESSOR OF CIVIL ENGINEERING, in the University of Ceylon—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (July 1).

SHELL STUDENTSHIP IN GEOPHYSICS—Dr. E. C. Bullard, Department of Geodesy and Geophysics, Cambridge (July 1).

CHAIR OF PUBLIC ADMINISTRATION at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 3).

CHAIR OF THEORETICAL PHYSICS—The Registrar, The University, Liverpool (July 7).

FOREST OFFICERS (5) IN THE FORESTRY DIVISION of the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (July 12).

LECTURERS IN PHYSICS, BOTANY, ZOOLOGY, GEOLOGY, and ASSISTANT LECTURERS IN MATHEMATICS, PHYSICS, CHEMISTRY, BOTANY, GEOLOGY, GEOGRAPHY, ENGINEERING—The Registrar, University College, Nottingham.

PHYSICIST (male or female) to the X-Ray Therapy and Radium Centre, St. Luke's Hospital, Guildford—The County Medical Officer, County Hall, Kingston-on-Thames.

PHYSICAL CHEMIST (male) for fundamental research on high-temperature reactions involving iron and other elements—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

PHYSICIST (mainly in connexion with radium and X-ray therapy)—The Secretary, Samaritan Free Hospital for Women, Marylebone Road, London, N.W.1.

TECHNICIAN IN THE MUSEUM AND HISTOLOGICAL DEPARTMENTS—The House Governor, Hospital for Sick Children, Great Ormond Street, London, W.C.1.

LECTURER IN PHARMACY—The Secretary, Royal Technical College, Glasgow.

LABORATORY TECHNICIAN (Grade C) IN THE PHYSIOLOGY DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.1.

SECRETARY—The Director of Research, British Baking Industries Research Association, Wellington House, 125–130 Strand, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Journal of Glaciology. Vol. 1, No. 1, January. Pp. 42. (London: British Glaciological Society, c/o Royal Geographical Society, 1947.) 7*s.* 6*d.* [81

Educational and General Interest Films, Sound and Silent. Pp. 80 + 12 plates. (London: G.B. Instructional, Ltd., 1947.) 2*s.* 6*d.* [91

Ministry of Health. Nurses Salaries Committee: Mental Nurses Sub-Committee. Further Recommendations. Mental Nurses S.C. Notes, No. 8. Pp. 10. (London: H.M. Stationery Office, 1946.) 2*d.* net. [81

Current Affairs, No. 19: The Future and the Atom Bomb. By Peter Wright. Pp. 20. (London: Bureau of Current Affairs, 1946.) 7*d.* [81

Atomic Survey: a Short Guide to the Scientific and Political Problems of Atomic Energy. Pp. 32. (Birmingham: Atomic Scientists' Association, Sec., Prof. P. B. Moon, The University, 1946.) [91

Other Countries

Memoirs and Observations of the Czechoslovak Astronomical Society. No. 7: A Hypothesis on the Origin of the Solar System and that of Multiple Stars. By Dr. Jan Šourek. Pp. 17. (Prague: Czechoslovak Astronomical Society, 1946.) [3012

Yale University School of Medicine. Sixth Annual Report of the Historical Library, 30 June 1946. Pp. 34. (New Haven, Conn.: Yale University, 1946.) [3012

Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation. Twenty-third Annual Report, 1946. Pp. 4. (Boston, Mass.: Dr. J. C. Aub, Sec., Massachusetts General Hospital, 1946.) [3012

State of California: Department of Natural Resources, Division of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 64: The Biology of the Soupfin, *Galeorhinus zyopterus*, and Biochemical Studies of the Liver. Pp. 96. (Terminal Island, Calif.: California State Fisheries Laboratory, 1946.) [81